# THE
# ART
# OF
# RACTICAL MEASURING,

Eaſily perform'd,

## y a Two-Foot RULE,

Which ſlides to a Foot;

n which is the beſt Meaſure of round Timber
he common Way: Alſo the true Meaſure of round,
ſquare, or other Timber or Stone, Board, Glaſs, Paving,
Painting, Wainſcot, *&c.* Gauging of Cask, and Gaug-
ng and Inching of Tuns.

ntaining, Brief Inſtructions in Decimal Arith-
metick. The beſt Way of uſing the Logarithms, ac-
cording to Mr. *Townley*. The Uſe of a New Diagonal
Scale of 100 Parts in a Quarter of an Inch, applied to
*Gunter's* Chain.

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*By* HENRY COGGESHALL, *Gent.* K

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*The* FOURTH EDITION.

---

which is added, in a conciſe Method, the Uſe
f *Scamozzi's* Lines, for finding the Lengths and Angles
f Hips and Rafters, *&c.* at any Pitch; illuſtrated by
chemes done from Copper Plates, in Frames, that are
quare, Bevelling, or Tapering.

---

whole carefully Reviſed, and where deficient ſupplied,
t it may be plain and eaſy to the meaneſt Capacity,

*By* JOHN HAM.

---

NDON: Printed for RICHARD KING at the
*Prince's-Arms* in St. *Paul's Church-yard.* 1729.

BRITISH MUSEUM

# THE PREFACE.

*THE general Approbation of this Rule hath cauſed me to review the Book. I have explained ſome Things, and added others, which thought uſeful.*

*Whether Mr.* Townley's *Contrivance of e Indices be treated of any where but in ir* Jonas Moore's *Mathematical Compen- ium, I could never learn; nevertheleſs, e Extraction of the Square and Cube oots of Decimals, according to that Con- ivance, being there wanting, I have given you here; ſo that the Root of a Decimal, hoſe Logarithm hath ſuch an Index, is und with equal Eaſe as that of a whole umber.*

*I have ſhewn how to find the Logarith to any Number of ſix Places, in Mr.* Wi gate's Tabulæ Logarithmicæ, *(omitte in the Explanation of the Tables) by th Differences at the Bottom, and a Slip o this Rule, it ſupplying the Place of a Ta ble of proportional Parts, which adds muc to the Uſefulneſs of the ſaid Book, in givin the Logarithm of any Number, as far as Million, with little Trouble.*

*The Gauging of Tuns is here ſhewn a cording to the modern Practice of Inchin I have given you a near Way of meaſurin a Solid that tapereth ſtrait, as alſo of fin ing the total Content of the Conical Tu and Stand, from Mr.* Everard, *whoſ Numbers for ten Inches Difference of Diameters, for the Parabola and Conoid, I hav alſo inſerted. Thus far Mr.* Coggeſhall.

*But in order to make this Treatiſe mor acceptable, there are ſeveral Correcti ons, Emendations, and Additions mad particularly in ſhewing the Uſe of a ne Three Foot Rule, which ſlides and ſhuts t a Foot, and which, for the Sake of th Reader's Peruſal, is neatly engraved upo*

a Coppe

*Copper Plate by that accurate Mathema-*
*al Inſtrument-maker Mr.* Thomas Heath
*the* Strand; *for our Author's is entirely*
*id aſide, as not being ſo compleat; his*
*aking uſe of both Sides of the Rule in*
*rking Proportions, whereas this makes uſe*
*t of one, which is not only a great Ad-*
*ntage in giving a Solution to all our*
*uthor's Propoſitions, but alſo reſerves the*
*her Side of the Rule for* Scamozzi's
*ines; which are Lines known to moſt*
*orkmen concerned in Buildings, to be of*
*eat Uſe in finding the Lengths and Angles*
*Hips and Rafters, and that by Inſpecti-*
*, when the Roof is true Pitch; and if*
*herwiſe, is here ſufficiently illuſtrated by*
*hemes done from Copper Plates, there*
*ing an Example of a Frame that has the*
*able End ſquare, and the Bevel hipt; and*
*nother where both Ends bevel, and the*
*ides run taper; in which laſt is ſhewn a*
*w Method of determining the Quantity of*
*e Angles, eſpecially of thoſe which relate*
*the Back of the Hips, ſo that they may*
*nſwer both Sides and Ends of the Roof;*
*nd laſtly, an Example of finding the*
*engths of Rafters for the Gable End of a*
*ouſe that bevels or lies out of ſquare, and*

*the fitting in of the Purloins, and findi their Lengths.*

*Moreover, upon one Leg or Joint of th Rule there is a Table, with which, by In ſpection, you may know what a Load Timber of* 50 *Feet will amount to, at a Price from* 6 d. *to* 2 s. per *Foot.*

*And if that which is here added prov uſeful, and render this Part of Buildi eaſy to Artificers in the Practice of the Buſineſs, it will be a Pleaſure to him, wh upon all Occaſions, is glad of promoting re and uſeful Knowledge.*

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JOHN HAM

ADVER

# ADVERTISEMENT.

MAthematicks in Theory and Practice, *viz.* Arithmetick Vulgar and Decimal, with all he uſeful Rules, Merchants Accompts, or the true *talian* Method of Book-keeping:

Algebra, Numerical and Literal, which is not nly applied to Practice in the Solution of Geomerical Problems, but to the reſolving of all Queſtins relating to ſimple and compound Intereſts, the reſent Worth of Annuities, Penſions, and Leaſes, &c.

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The Uſe of the Globes, the Calculation and Conſtruction of Solar and Lunar Eclipſes, and ther Parts of Mathematicks, Are taught

## *By* JOHN HAM,

Maſter of the Mathematical School at the Chapel n *Hatton-Garden, Holborn*: Which requiring his ttendance but three Days in a Week, *viz. Mondays, Wedneſdays,* and *Fridays,* the other three his Buſineſs lies altogether with Gentlemen at their wn Houſes.

THE

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THE

# THE
# ART
# OF
# Practical Meaſuring, &c.

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## PART I.

---

ALtho' the way of Meaſuring by this Rule is ſo eaſy, that many, without the Art of Arithmetick, do underſtand and uſe it, as far as their particular Occaſions require; yet it is convenient for a Meaſurer to have me Skill therein, eſpecially in the five firſt Parts ereof.

There are Books of that Subject, written by di- rs, to be had at eaſy Rates, whereof only the ter Authors treat of Decimal Arithmetick and garithms. By the former of theſe, the trouble-ſome Way of working with the vulgar Fractions is avoided; by the other, Multiplication and Diviſion are eaſily performed by Addition and Subtraction, and conſequently the moſt uſeful Parts of Arithmetick are rendered far more eaſy and expeditious.

Both theſe, ſince they firſt came into uſe, have been improved. The four Rules in Diviſion of Decimals, delivered by Mr. *Wingate* in his firſt Treatiſes of Arithmetick, are by Mr. *Kerſy* reduced to one, which follows after; and Mr. *Townley*'s Indices free the Operation by Decimals from Multiplicity of Rules, and give you the Rate or Value of them directly.

I have therefore here premiſed a ſhort Treatiſe of Decimal Arithmetick, and of the Nature and Uſe of the Logarithms; noting firſt, that the beſt way (in my Opinion) of reading Decimals, is, as you read whole Numbers, giving them the Name of the Value of the laſt Figure to the right Hand. To which purpoſe you may call them more eaſy, if inſtead of Tenths, Hundredths, Thouſandths, Ten-Thouſandths, &c. you ſay, Tenths, Cents, Milleſms, Decimilleſms, Centimilleſms, Millemilleſms, &c. as this .00165, I read thus, 165 Centimilleſms; and ſo of any other.

## SECTION I.

### *Notation, Addition, Subtraction, Multiplication and Diviſion in Decimals, alſo with whole or mixt Numbers.*

A Decimal is the Numerator of a Fraction, whoſe Denominator is an Unit with one or more Cyphers; which Denominator is not expreſſed, it being known by the Numerator. For ſo many Places or Figures as are in the Numerator or Decimal, ſo many Cyphers are ſuppoſed to be adjoined to the Unit in the Denominator.

It ought to have a Point before it, as a Badge whereby it is known, being otherwiſe written as a whole Number: Therefore a Decimal of one place is Tenths, as this .2 is two Tenths; of two places is Hundredths, as this .02 is two Hundredths; of three is Thouſandths, as this .002, &c. the ſignificant Figures being put by the Cyphers into Places of leſs Value, and the Places decreaſing from Unit in a ten-fold Proportion.

*Or thus.* Call ſuch as have a ſignificant Figure ext after the Point, as theſe, .3, .25, .732, &c. Decimals of the firſt Rank or Rate. Such as have ne Cypher after the Point, as theſe .08, .0134, &c. Decimals of the ſecond Rank or Rate. Such s have two Cyphers after the Point, Decimals of he third Rate, &c. The Convenience whereof ou will find afterwards.

The Work is the ſame as in the whole Numbers; et take theſe Directions.

1. If you uſe a whole Number with mixt Numers or Decimals, let it have always a Point after .

2. In Addition and Subtraction, the Points pre-xt to the Decimals muſt be ſet under one another, y which means the Units in the whole or mixt umbers ſtand alſo under one another.

3. In Subtraction, although a Cypher at the ght Hand of a Decimal is of no Value, (as theſe, , .50, .500, are no more than 5 Tenths, or one lf) yet if the Decimals conſiſt not of an equal umber of Places, or if one of the Numbers be a hole Number, you muſt annex Cyphers, or ſup-ſe them annexed.

### *Examples of Addition.*

| | | | | |
|---|---|---|---|---|
| 22.75 | 19.2 | .17 | 32.78 | .34 |
| 9.6 | 4.68 | .89 | 12. | .178 |
| | | | | .84 |
| 32.35 | 23.88 | 1.06 | 44.78 | .7 |
| | | | | 2.058 |

### *Examples of Subtraction.*

| | | | |
|---|---|---|---|
| 22.75 | 19.2 | 107. | 48.16 |
| 9.6 | 4.68 | 8.93 | 17. |
| 13.15 | 14.52 | 98.07 | 31.16 |

### *Multiplication.*

1. But in Multiplication, ſet them as if they were whole Numbers, and ſo multiply them: Cutting off from the Product found ſo many Figures to the right Hand, as there are Places of Decimals, both in the Multiplicand, and the Multiplier; ſo the Reſidue is the whole Part of the Product, and the Figures cut off, the Decimal.

2. If the Product hath not ſo many Places, as there are Places of Decimal Parts in both Numbers; ſupply the deficient Places with Cyphers prefixed to the left Hand.

### *Examples.*

| | | | | | |
|---|---|---|---|---|---|
| 46.25 | .87 | 564. | .0375 | .76 | .22 |
| 35. | .9 | .25 | .05 | 8. | .07 |
| 23125. | .783 | 2820 | .001875 | 6.08 | 1.54 |
| 13875 | | 1128 | | | |
| 1618.75 | | 141.00 | | | |

By theſe Examples you ſee how the whole Part of the Product is diſtinguiſhed from the Decimal Part thereof.

## *Diviſion.*

In Diviſion it is ſomething harder to diſtinguiſh he whole Part of the Quotient from the Decimal Part thereof.

*Firſt*, Annex Cyphers to the Dividend, at pleaſure, or leave Space for them, that the Diviſion may be continued to a ſufficient Quotient. Then lace the Diviſor under it according to the old way f Diviſion; but ſo as if they were both whole Numbers: Then obſerve well what Place or Degree f the Dividend ſtandeth over the Place of Units n the Diviſor; whether theſe Places be real, or nly ſuppoſed; of the ſame Degree or Place is the irſt Figure in the Quotient. Which being once oted, you need not regard the Points nor Cyphers at either End of the Diviſor, any more; ut continue the Diviſion, as if both were whole Numbers.

See here the Degrees of Numbers as they ſtand n their natural Order, which may be continued ither Way from Unit.

| *houſ.* | *Hund.* | *Tens.* | *Unit.* | *Tenths.* | *Hundredths.* | *Thouſandths.* |
|---|---|---|---|---|---|---|
| 000. | 100. | 10. | 1. | .1 | .01 | .001, &c. |

I have here ſet down ſome Examples, wherein u may ſee how the Diviſor is placed under the ividend at the firſt Queſtion, and alſo the two ſt Figures in the Quotient.

| | | | |
|---|---|---|---|
| *ivid.* | 180.000 (30. &c. | *Divid.* | 1.75000 (.02, &c. |
| *iviſ.* | 5.875 | *Diviſ.* | 63. |
| *ivid.* | 1.00000(.083,&c. | *Divid.* | .748000 (91. &c |
| *iviſ.* | 12. | *Diviſ.* | .0082 |

*Divid.* 9.72000 (21. &c.
*Diviſ.* .45

In the two laſt Examples; although there be neither Units Place in the Diviſor, nor (if there were) any Figure over it in the Dividend; yet by ſuppoſing the Places continued to the left hand, or ſupplying them with Cyphers, you will ſee that the firſt Place in the Quotient is the Place of Tens.

I account that way of Diviſion the beſt, in which, after (upon Examination by multiplying the Diviſor by the anſwering Figure from the left Hand toward the right) you have found the fir Figure to be put in the Quotient; you proceed, in your Diviſion to multiply the Diviſor by the anſwering Figure, beginning with the Figure in the Diviſor next the right Hand. If the Figur over it in the Dividend be not great enough to tak the Product out of it; call it ſo many Tens, mor than it is, as will make it great enough, but n more; and then ſubtract; ſetting the remainin Figure over it, and cancel the ſaid Figure: An for the Tens added, call the Product of the nex Figure ſo many Units more than it is. Admit th Product 36 muſt be taken out of 2; call the 42, and ſubtract. Suppoſe the next Product is 18 call it 22, *&c.* which Way you make feweſt Fi gures, and is no more Burthen to the Memory tha ordinary Multiplication.

*To multiply or divide any whole Number, mi Number, or Decimal, by* 10, 100, 1000, &c. *b removing the Point.*

To multiply: Remove the Point ſo many Plac to the right Hand as there are Cyphers in the Mu tiplier: If Figures be wanting, ſupply them wi

Cyphe

yphers, as here, 2.7 by 10 is 27.: .13 by 100, is :02 by 10, is .2.

To divide: Remove the Point ſo many Places the left Hand, as there are Cyphers in the Di- ſor: If Places be wanting, ſupply them with yphers, as here, 27. by 10 is 2.7.: .13 by 100, is 013: .02 by 10, is .002.

## SECT. II.

## *LOGARITHMS.*

Urpoſing to give you the Solution of ſome of the Queſtions in this Book by thoſe excellent umbers the Logarithms; take theſe Directions r the better underſtanding the Nature and Uſe of em.

They are artificial Numbers, fitted to the na- ral, for the Eaſe of Calculation; and are printed Tables having two Columns. One hath the tural Number; againſt it in the other is his ogarithms: So that the Logarithm of a whole umber is eaſily found.

The Tables begin at 1, whoſe Logarithm is 00000; and reach commonly to 10,000; conſiſt- g every one of 8 Figures. though (unleſs in grea umbers) we ſeldom uſe above ſix; (if the Figures t out exceed 50, we put an Unit to the ſixth) the Logarithms are annexed Differences; by the elp of which, and a Table of proportional Parts joined, you are directed to find the Logarithm any Number to 100,000. But theſe are but of Places.

Mr. *Wingate*, in his *Tabulæ Logarithmicæ*, hath e Logarithms to 100,000, with Differences alſo; hereby making a Proportion, (which is done eedily by one Slip of this Rule) you have the ogarithms as far as 1,000,000, in a portable Volume for the Pocket. A Book which I commend to any that delight in Arithmetick.

The firſt Figure, called the Index, (which i commonly ſeparated by a Point, better left out except in the firſt hundred, as in the late printed Tables) ſhews how many Figures the anſwering Number, if whole, or the whole Part thereof, i it hath a Decimal annexed, conſiſteth of; which are always more by one than the Index. So 0. i the Index of one Figure, 1. of two Figures, 2. of three, 3. of four, &c.

Alſo according to the excellent Way of Mr. *Chriſtopher Townley*, cited by Sir *Jonas Moor* in hi Mathematical Compendium, the Log. of a Decima is the ſame, as if it were a whole Number, with this Direction for the Index.

If the Decimal be of the firſt Rate, the Index i 9; if of the ſecond Rate, the Index is 8; if of the third Rate, the Index is 7, &c. that is, the Index of the Logarithm of any Decimal, wants as man Units of Ten, as the left Hand ſignificant Figure i diſtant from Unity: Which, I hope, you will underſtand, if you obſerve this following Table.

| *Perf. Numb.* | *Log.* |
|---|---|
| 3536. | 3.54851 |
| 353.6 | 2.54851 |
| 35.36 | 1.54851 |
| 3.536 | 0.54851 |
| *Decimals.* | *Log.* |
| .3536 | 9.54851 |
| .03536 | 8.54851 |
| .003536 | 7.54851 |
| .0003536 | 6.54851 |

Where you ſee, That in the perfect Numbers, the Index ſheweth the Number of Places in the whole Numbers, and in the whole Part of the mixt, being always leſs by one than the ſaid Places; but in Decimals it ſheweth the Rate, being the Complement thereof to Ten, not regarding the Number of Places.

If then you would have the Log. of any Number, find the Log. thereof in the Table, as if it we

hole ; and prefix the Index anſwering the Va-
ue.

And having a Log. find the Number anſwer-
g in the Table, and by a Point fix the Value
ccording to the Index.

### *o find a Log. to a Number of ſix Places in the* Tabulæ Logarithmicæ *by help of this Rule.*

Call the Difference at the Bottom the Tabular ifferences. Having the Log. of the five firſt igures, by the double Scale on your Rule, ſet 10 the Tabular Differences ; againſt your ſixth igure is his proportional Part to be added to the og. before found.

### *To find a Number of ſix Places anſwering a Log. given.*

Find the Number of five Places anſwering the og. in the Table, next leſs to the given Log. ſub- ct the ſaid Log. out of the given Log. call the emainder the proper Difference ; then by the uble Scale on your Rule ſet 10 to the Tabular Dif- ence ; againſt the proper Difference on the ſecond, your ſixth Figure on the firſt, to be annexed to e five Figures before found.

*Note*, That you muſt uſe all the eight Figures theſe Caſes.

### *Some Uſes of the Logarithms.*

Whereas, before the aforeſaid Contrivance of the dices by Mr. *Townley*, if one Number were per- t, and the other a Decimal, there was a different le in every Operation for them ; but by the ſaid ntrivance one is now ſufficient : I will give Ex- ples only, in which one Number is a Decimal, th theſe two Directions.

1. In the Log. which anſwereth the Queſtio (whether it be a Sum, Remainder, Half, &c.) i the Index be ten, or above, neglect or cancel th ſaid Figure in the Place of Tens.

2. Where you are ordered to ſubtract a great Log. out of a leſs; add ten to the Index of th leſs, and then ſubtract.

### 1. *Multiplication.*

Add the Logs. of the two, or more Numbers to be multiplied; the Sum is the Log. of the Product. So 12 multiplied by the Decimal .25, the Product is 3.

| | |
|---|---|
| 12. | 1.0791 |
| *By* .25 | 9.3979 |
| 3. | 0.4771 |

It may alſo be done where there are but tw by ſubtracting the Arithmetick Complement of th Log. of one of them out of the Log. of the other the Remainder is the Log. of the Product.

Which Arithmetical Complement is the Remainder of every Figure, (including the Index) to 9; except of the laſt ſignificant Figure to the right Hand, whoſe Remainder you muſt take to Ten. As in theſe three Examples.

| *Numb.* | | |
|---|---|---|
| 2. | 0.30103 | *Log.* |
| .5 | 9.69897 | *Ar. Comp* |
| *Numb.* | | |
| 80. | 1.90309 | *Log.* |
| .0125 | 8.09691 | *Ar. Comp* |
| *Numb.* | | |
| 100. | 2.00000 | *Log.* |
| .01 | 8.00000 | *Ar. Comp* |

### 2. *Diviſion.*

Subtract the Log. of the Diviſor out of the Lo of the Dividend, (whether of the two be greater or leſs) the Remainder is the Log. of the Quotient. So 12 divided by the Decimal .25; the Quotient is 48.

| | |
|---|---|
| 12. | 1.0791 |
| *By* .25 | 9.3979 |
| 48. | 1.681 |

It may alſo very conveniently be done, by adding e Ar. Compl. of the Log. of the Diviſor to the g. of the Dividend; the Sum is the Log. of the uotient, as followeth.

### 3. *The Rule of Three Direct.*

1. Add the Logarithms of the ſecond and third; m the Sum ſubtract the Log. of the firſt; the mainder is the Log. of the fourth.

2. A better Way: Add the Ar. Compl. of the g. of the firſt to the Logarithms of the ſecond third; the Sum is Log. of the fourth.

*ample.* If .25 give 16. hat ſhall 12. give?

*Anſwer*, 768.

| | | |
|---|---|---|
| *Ar. Compl.* | .25 | 0.60206 |
| | 16. | 1.20412 |
| | 12. | 1.07918 |
| | 768. | 2.88536 |

But in the inverſe Rule: Add the Ar. Compl. he Log. of the third to the Logarithms of the t and ſecond; the Sum is the Log. of the fourth. us are reſolv'd the Queſtions wrought on the uble Scale.

But for thoſe in this Book, where there is a du- cate Proportion, as in Timber Meaſure and Gaug- , if the firſt and third Numbers be on the ſquare e, there are general or fixt Logarithms belong- to the firſt Numbers; to which if you add the g. of the ſecond, and the Log. of the third twice, Sum of all four is the Log. of the fourth.

f the ſecond and fourth Numbers be on the are Line; to the Ar. Compl. of the Log of the add the Log. of the third, and the Log. he ſecond twice, half the Sum is the Log. of fourth.

### 4. *The Square Root.*

Half the Log. of the Number given, is the full g. of the Square Root.

If the Number be a Decimal, add ten to the Index, and then halve it, as here.

.25 19.3979
.5 9.6989

## 5. *The Cube Root.*

The third Part of the Log. of the Number give is the full Log. of the Cube Root.

If the Number be a Decimal, add twenty to the Index, and then divide by three, as here.

.25 29.3979
.63 9.7993

## 6. *To find a mean Proportional between two Numbers.*

Add their Logs. together: Half the Sum is t Log. of the mean Proportional.

When one is a Decimal, if the Sum of the Indices be ten, (as here) or above; caſt away ten, and then halve it; if it be not ten, add ten to it, and then halve it.

12. 1.079
.25 9.397

10.477
1.732 0.238

## 7. *To find two, or more mean Proportionals between two Numbers.*

This, in Caſe of a Decimal, was ſomething p plex'd, as you may ſee in Mr. *Wingate*'s Artific Arithmetick: It is now, by the aforeſaid Cont vance of Mr. *Townley*, as eaſy, as it is uſeful.

Subtract the Log. of the leſs Number out of the Log. of the greater: The Remainder divide by a Number greater by one, than the Number of means ſought; as here by 4 for three means.

12. 1.079
.25 9.397

1.681
420

Th

This Quotient added to the Log. of the leſs Number; the Sum is the Log. of the firſt Mean; to which adding again the ſaid Quotient, the Sum is the Log. of the ſecond Mean. And ſo forward for as many Means, as the Quotient was at firſt ordered for.

| | | *Means.* |
|---|---|---|
| | | 9.39794 |
| | | 42031 |
| 1 | .658 | 9.81825 |
| | | 42031 |
| 2 | 1.732 | 0.23856 |
| | | 42031 |
| 3 | 4.556 | 0.65887 |

### 8. *To find the Log. of a Vulgar Fraction.*

Subtract the Log. of the Denominator out of the Log. of the Numerator, the Remainder is the Log. of a Decimal equivalent to the ſaid vulgar Fraction.

| | |
|---|---|
| $\frac{3}{4}$ | 0.47712 |
| | 0.60206 |
| .75 | 9.87506 |

### 9. *To find the Log. of a Number with a Vulgar Fraction annex'd.*

Suppoſe it to be 12 $\frac{1}{4}$; change the Number into n improper Fraction, by multiplying the whole Number by the Denominator of the Fraction, and dding the Numerator to the Product, the Sum is he Numerator of the improper raction.

Then ſubtract the Log. of the enominator out of the Log. of he Numerator, as before; the Remainder is the Log. of the ſaid Number, with a ecimal, equal to the ſaid vulgar Fraction, annex'd.

| | |
|---|---|
| $\frac{49}{4}$ | 1.69020 |
| | 0.60206 |
| 12.25 | 1.08814 |

I have, as an Appendix to this Part, adjoined he uſual Decimal Tables, and compriſed them nto five: Yet the Uſe of them is as eaſy, as if hey were all ſingle.

The Integers, or Wholes, are ſet on the Top; nd the Parts follow in order, with their Decimals nnexed.

# TABLE I.

*A Table of* Engliſh *Coin, a Pound Sterling, alſo Troy Weight, an Ounce* } *Integer.*

| Shillings and Penny weight. | Decimals. | Pence with Farthings. | Decimals. | Grains. |
|---|---|---|---|---|
| 19 | .95 | 3 | .0489583 | |
| 18 | .9 | 2 | .0479166 | 23 |
| 17 | .85 | 1 | .046875 | |
| 16 | .8 | 11 | .0458333 | 22 |
| 15 | .75 | 3 | .0447916 | |
| 14 | .7 | 2 | .04375 | 21 |
| 13 | .65 | 1 | .0427083 | |
| 12 | .6 | 10 | .0416666 | 20 |
| 11 | .55 | 3 | .040625 | |
| 10 | .5 | 2 | .0395833 | 19 |
| 9 | .45 | 1 | .0385416 | |
| 8 | .4 | 9 | .0375 | 18 |
| 7 | .35 | 3 | .0364583 | |
| 6 | .3 | 2 | .0354166 | 17 |
| 5 | .25 | 1 | .034375 | |
| 4 | .2 | 8 | .0333333 | 16 |
| 3 | .15 | 3 | .0322916 | |
| 2 | .1 | 2 | .03125 | 15 |
| 1 | .05 | 1 | .0302083 | |
| | | 7 | .0291666 | 14 |
| | | 3 | .028125 | |
| | | 2 | .0270833 | 13 |
| | | 1 | .0260416 | |
| | | 6 | .025 | 12 |
| | | 3 | .0239583 | |
| | | 2 | .0229160 | 11 |
| | | 1 | .021875 | |

*The Reſidue of the Table.*

| Pence with Farthings. | Decimals. | Grains. |
|---|---|---|
| 5 | .0208333 | 10 |
| 3 | .0197916 | |
| 2 | .01875 | 9 |
| 1 | .0177083 | |
| 4 | .0166666 | 8 |
| 3 | .015625 | |
| 2 | .0145833 | 7 |
| 1 | .0135416 | |
| 3 | .0125 | 6 |
| 3 | .0114583 | |
| 2 | .0104166 | 5 |
| 1 | .009375 | |
| 2 | .0083333 | 4 |
| 3 | .0072916 | |
| 2 | .00625 | 3 |
| 1 | .0052083 | |
| 1 | .0041666 | 2 |
| 3 | .003125 | |
| 2 | .0020833 | 1 |
| 1 | .0010416 | ½ |
| ½ | .0005208 | ½ |

# TABLE II.

## Averdupois *great Weight, One hundred at* 112l. *Integer.*

| Quarters. | Decimals. |
|---|---|
| 3 | .75 |
| 2 | .5 |
| 1 | .25 |

| Pounds. | Decimals. |
|---|---|
| 27 | .2410714 |
| 26 | .2321428 |
| 25 | .2232143 |
| 24 | .2142857 |
| 23 | .2053571 |
| 22 | .1964286 |
| 21 | .1875 |
| 20 | .1785714 |
| 19 | .1696428 |
| 18 | .1607143 |
| 17 | .1517857 |
| 16 | .1428571 |
| 15 | .1339286 |
| 14 | .125 |
| 13 | .1160714 |
| 12 | .1071428 |
| 11 | .0982143 |
| 10 | .0892857 |
| 9 | .0803571 |
| 8 | .0714286 |
| 7 | .0625 |
| 6 | .0535741 |
| 5 | .0446428 |
| 4 | .0357143 |
| 3 | .0267857 |
| 2 | .0178571 |
| 1 | .0089286 |

*The Reſidue of the Table.*

| Ounces | Decimals. |
|---|---|
| 15 | .0083705 |
| 14 | .0078126 |
| 13 | .0072545 |
| 12 | .0066964 |
| 11 | .0061384 |
| 10 | .0055803 |
| 9 | .0050223 |
| 8 | .0044643 |
| 7 | .0039062 |
| 6 | .0033482 |
| 5 | .0027902 |
| 4 | .0022321 |
| 3 | .0016741 |
| 2 | .0011161 |
| 1 | .000558 |

| Quarters. | Decimals. |
|---|---|
| 3 | .0004185 |
| 2 | .000279 |
| 1 | .0001395 |

## TABLE III.

**Averdupois** *little Weight, one Pound* } *Integer.*
*long Meaſure, one Yard or Ell,*

| Ounces | Decimals. | Qtrs with Nails. |
|---|---|---|
| 15 | .9375 | 3 |
| 14 | .875 | 2 |
| 13 | .8125 | 1 |
| 12 | .75 | 3 |
| 11 | .6875 | 3 |
| 10 | .625 | 2 |
| 9 | .5625 | 1 |
| 8 | .5 | 2 |
| 7 | .4375 | 3 |
| 6 | .375 | 2 |
| 5 | .3125 | 1 |
| 4 | .25 | 1 |
| 3 | .1875 | 3 |
| 2 | .125 | 2 |
| 1 | .0625 | 1 |

*The Reſidue of the Table.*

| Drams | Decimals. | Qtrs of Nails. |
|---|---|---|
| 15 | .0585937 | |
| 14 | .0546875 | |
| 13 | .0507812 | |
| 12 | .046875 | 3 |
| 11 | .0429687 | |
| 10 | .0390625 | |
| 9 | .0351562 | |
| 8 | .03125 | 2 |
| 7 | .0273437 | |
| 6 | .0234375 | |
| 5 | .0195312 | |
| 4 | .015625 | 1 |
| 3 | .0117187 | |
| 2 | .0078125 | |
| 1 | .0039062 | |

| Quarters. | Decimals. |
|---|---|
| 3 | .0029297 |
| 2 | .0019531 |
| 1 | .0009765 |

## TABLE IV.

*Liquid Meaſure, one Gallon.*
*Dry Meaſure, one Quarter.* } *Integer.*

| Pints. | Decimals | Buſhels |
|---|---|---|
| 7 | .875 | 7 |
| 6 | .75 | 6 |
| 5 | .625 | 5 |
| 4 | .5 | 4 |
| 3 | .375 | 3 |
| 2 | .25 | 2 |
| 1 | .125 | 1 |
| Quarters. | Decimals | Pecks. |
| 3 | .09375 | 3 |
| 2 | .0625 | 2 |
| 1 | .03125 | 1 |
| | Decimals | Quarters of a Peck. |
| | .0234375 | 3 |
| | .015625 | 2 |
| | .0078125 | 1 |
| | Decimals | Pints. |
| | .0058594 | 3 |
| | .0039063 | 2 |
| | .0019531 | 1 |

## TABLE V.

*Dozens, or Groſs*
*Time, one Year.*
*Long Meaſ. 1 Foot*
*Pence, one Shilling* } *Integer.*

| Dozens. Months. | Decimals | Inches Pence. |
|---|---|---|
| 11 | .9166667 | 11 |
| 10 | .8333333 | 10 |
| 9 | .75 | 9 |
| 8 | .6666667 | 8 |
| 7 | .5833333 | 7 |
| 6 | .5 | 6 |
| 5 | .4166667 | 5 |
| 4 | .3333333 | 4 |
| 3 | .25 | 3 |
| 2 | .1666667 | 2 |
| 1 | .0833333 | 1 |
| Parts. | Decimals | Quarters & Farth. |
| 11 | .0763889 | |
| 10 | .0694444 | |
| 9 | .0625 | 3 |
| 8 | .0555555 | |
| 7 | .0486111 | |
| 6 | .0416667 | 2 |
| 5 | .0347222 | |
| 4 | .0277778 | |
| 3 | .0208333 | 1 |
| 2 | .0138889 | |
| 1 | .0069444 | |

## *Days belonging to the Table of Time.*

| Days. | Decimals. | Days. | Decimals. |
|---|---|---|---|
| 30 | .08219178 | 15 | .0410959 |
| 29 | .079452 | 14 | .0383562 |
| 28 | .0767123 | 13 | .0356164 |
| 27 | .0739726 | 12 | .0328767 |
| 26 | .0712329 | 11 | .030137 |
| 25 | .0684931 | 10 | .0273972 |
| 24 | .0657534 | 9 | .0246575 |
| 23 | .0630137 | 8 | .0219178 |
| 22 | .060274 | 7 | .0191781 |
| 21 | .0575342 | 6 | .0164383 |
| 20 | .0547945 | 5 | .0136986 |
| 19 | .0520548 | 4 | .0109589 |
| 18 | .0493151 | 3 | .0082192 |
| 17 | .0465753 | 2 | .0054794 |
| 16 | .0438356 | 1 | .0027397 |

### *To bring Decimals into known Parts.*

Multiply the Number of Parts in one Integ and the Decimals together: From the Produ cut off ſo many Figures to the right Hand as are i the Decimals (as you are directed in Multiplicatio of Decimals.) The Reſidue to the left Hand are th Parts ſought; and the Figures cut off are a De mal of one of thoſe Parts, to be reduced the ſa Way into the next leſs Parts, if there be any, or there be need. If nothing be left to the left Han there is not one of thoſe Parts in that Decimal Therefore account it cut off, and proceed to fi the next leſs Parts, as before.

The making the foregoing Tables is by dividi the Numerator of the vulgar Fraction, which r preſen reſents the Parts, by the Denominator ; the Quo-ient is the Decimal. So $\frac{11}{20}$ being the vulgar Fraction of eleven Shillings or eleven Penny Weights ; f you divide 11 by 20, the Quotient .55 is the Decimal : So that half the Number of Shillings or Penny Weights is the Decimal. Alſo $\frac{26}{960}$ being he vulgar Fraction of 6 *d.* $\frac{1}{2}$, or of 26 Farthings ; f you divide 26 by 960, the Quotient .0270830, *&c.* is the Decimal.

Yet you ſhall not need Diviſion for every Decimal ; for ſome are found by halving the Integer or 1 ; and ſo continually : So are found the Decimal of one half, one quarter, one half quarter, *&c.* Some are found by halving a Decimal before found : So half the Decimal of a Shilling, is the Decimal of Six-pence ; half of that, the Decimal of Three-pence, *&c.* Alſo one third Part of the Decimal of a Shilling, is the Decimal of Fourpence ; and the half of that, the Decimal of Twopence, *&c.* and the double of it the Decimal of Eight-pence. Likewiſe the Sum of two Decimals, is the Decimal of the Sum of the two Fractions, whoſe Decimals they are ; and the Difference is the Decimal of their Difference.

Some of theſe are of one Place, and ſome of more : Few Tables have them to above ſeven ; and moſt ordinary Queſtions may be reſolved to a ſufficient Exactneſs, if you uſe but four ; remembering the Direction above given, *viz.* If the firſt Figure of thoſe left out exceed 5, to add a Unit to the laſt of thoſe you retain.

If the Anſwer of a Queſtion be in Money, three Places of Decimals give it to near a Farthing, as is ſhewn after *Part* 4. *Prop.* 5.

Now for the Uſe of them in a Queſtion or two.

1. At 5*s.* 3*d.* $\frac{1}{2}$ the Ounce ; what coſt 7 Ounces, 3 Penny Weight, and 19 Grains ?

Having added the Decimals of the Parts, the Queſtion will ſtand thus:

*ou.* *l.* *ou.* *l.*
1 : 0.2645833 : : 7.1895833 : 1.9022

The Product or Anſwer is 1 *l.* 9022, *&c.* Which is 1 *l.* 18 *s.* 0 *d.* 2 *f.* near.

If you leave out the three laſt Figures in each Decimal, with the Condition above-mentioned, the Numbers are

*ou.* *l.* *ou.*
1 : 0.2646 : : 7.1896,

And the Anſwer is 1 *l.* 9023, *&c.* differing from the other inconſiderably.

2. To compute ſimple Intereſt for any Sum, Rate, and Time. Having put the Parts, if there be any, into their Decimals; multiply the Principal and the Rate; from the Product cut off the due Decimal, if any, and two Places more for the Diviſion by 100: This Product ſo ordered is the Intereſt due for one Year; which if you multiply by the Time, (be it more or leſs than a Year) the Product (the due Decimal cut off) is the Intereſt for that Time.

*Examp.* 1. What is the ſimple Intereſt of 132 *l.* 7 *s.* 6 *d.* for 2 *y.* 3 *m.* 22 *d.* at 6 *l.* in the Hundred?

The Decimal of 7 *s.* 6 *d.* is ,375; which being annexed to the whole Pounds, the Principal will be 132 *l.* 375; which multiply'd by 6, and the Product ordered as directed, it will be 7.9425, or 7 *l.* 18 *s.* 10 *d.* 1 *f.* near, for the Intereſt for one Year. But that being not the Sum ſought, multiply the ſaid 7.9425 and the Time, *viz.* 2 *y.* 3103, the Product 18.3493 is the Intereſt ſought, *viz.* 18 *l.* 6 *s.* 11 *d.* 3 *f.*

*Ex.* 2. What is the Intereſt of the ſaid Sum for two Months and ten Days at the ſame Rate? Multiply the ſaid 7.9425 by .1941 the Decimal of the Time, the Product 1 *l.* 5416, or 1 *l.* 10 *s.* 10 *d.* is the Intereſt ſought.

But the great Convenience of Decimals is, that their Logs. are ſo eaſily found; as is already ſhewn in this ſecond Section. So that by the *Tabulæ Logarithmicæ* mentioned in the aforecited Place, any Queſtion, whoſe Numbers (whether whole, mixt, or Decimals) exceed not ſix Places, may be ſpeedily reſolved: Mr. *Townley's* Indices of the Decimals freeing us from Perplexity of different Rules. As in the two laſt Examples.

To the Arith. Compl. of the Log. of 100, *viz.* 8.0000000 add the Log. of the Principal and of the Rate; the Sum is the Log. of the Intereſt for one Year. To which Log. if you add the Log. of the Time, this Sum ſhall be the Log. of the Intereſt for the Time.

Or without ſeeking the Intereſt for one Year: To the ſaid Ar. Compl. add the Logs. of the Principal, Rate, and Time, the Sum ſhall be the Log. of the Intereſt demanded, as in the ſecond Example.

*Example* 1.

| | |
|---|---|
| 100. *Ar.Com.* | 8. |
| 132.375 | 2.1218052 |
| 6. | 0.7781512 |
| 7.9425 | 0.8999571 |
| 2.3103 | 0.3636683 |
| 18.3495 | 1.2636254 |

*Example* 2.

| | |
|---|---|
| 100. *Ar.Com.* | 8. |
| 132.375 | 2.1218059 |
| 6. | 0.7781512 |
| .1941 | 9.2880255 |
| 1.5416 | 0.1879826 |

3. Compound Intereſt for any Principal, Rate, and Time by the Logarithms.

In this Propoſition the Excellency of thoſe Numbers appear; ſuch Queſtions being reſolved by them with great Eaſe and Speed; but by natural Arithmetick not without conſiderable Time and Trouble.

Deduct the Log. of 100 from the Log. of 100, and the Rate added together, as 105, 106, &c. The Difference multiply by the Time: From the Product cut off the Decimal, if there be any: The Remainder add to the Logarithm of the Principal; the Sum is the Logarithm of the Principal and Intereſt required.

### *Example.*

Let the Principal, Rate, and Time be as in the former of the two laſt Queſtions. Purſuing the Rule, as you ſee in the Margin; the Sum of the principal and compound Intereſt is 151 *l.* 9 *s.*

| | | |
|---|---|---|
| *The Difference* | | 253058 |
| *The Time* | | 2.3103 |
| *The Product* | | 584639.8974 |
| | 132.375 | 2.1218059 |
| | | 584639 |
| | 151.45 | 2.1802698 |

It ſeems by this, that the Intereſt of 100 *l.* at 6 *l. per Cent.* by the Year, is not fully amounted to 3 *l.* in ſix Months; for if you multiply the aforeſaid Difference by 5, the Decimal of ſix Months; and, having cut off one Place, add the Reſidue to the Log. of 100, the Sum will be 2.0126529; which is the Log. of 102.956, that is 102 *l.* 19 *s.* 1 *d.* 1 *f.*

I will add two or three Examples more, which, I hope, will be ſufficient.

1. What is the Value of 28 Ounces, ſix Penny Weights and 15 Grains of Gold, at 3 *l.* 3 *s.* 6 *d.*

he Ounce? Annexing the Decimals to the Integers, the Numbers ſtand thus:

| | ou. | l. | ou. | l. |
|---|---|---|---|---|
| | 1 : | 3.175 : : | 28.33125 : | 89.952 |

| l. s. d. f. | | |
|---|---|---|
| acit, 89 . 19 . 00 . 2 | 3.175 | 0.5017437 |
| | 28.33125 | 1.4522657 |
| | 89.952 | 1.9540094 |

2. If 4 . 9 . 12 ou. p. gr. of Gold coſt 14 . 10 . 9 l. s. d.; hat is that the Ounce?

| | ou. | l. | ou. | l. |
|---|---|---|---|---|
| he Numbers are | 4.475 : | 14.51875 : : | 1 : | 3.2444 |

| l. s. d. f. | | | |
|---|---|---|---|
| cit, 3 . 04 . 10 . 2. | 4.475 | Ar. Compl. | 9.3492070 |
| | 14.51875 | | 1.1619291 |
| | 3.2444 | | .5111361 |

3. At 6 *s.* 3 *d.* the Ounce; how much Silver ate will 5 *l.* 3 *s.* 6 *d.* buy?

| | l. | ou. | l. | ou. |
|---|---|---|---|---|
| The Numbers are | 0.3125 : | 1 : : | 5.175 : | 16.56 |

| ou. p. gr. | | | |
|---|---|---|---|
| cit, 16. 11. 05 near. | .3125 | Ar. Compl. | 0.50515 |
| | 5.175 | | 0.71391 |
| | 16.56 | | 1.21906 |

I have taken but ſix Figures in this laſt Example. I had uſed no more in the other, the Difference uld have been little or inconſiderable; as you y find if you pleaſe to give yourſelf that ſmall ouble.

Theſe thus premiſed, I ſhall come next to the Deſcription and Uſes of the Rule in ſeveral Meaſures; wherein I ſhall uſe theſe vulgar Fractions, *viz* $\frac{1}{4}$ one Quarter, $\frac{1}{2}$ one Half, $\frac{3}{4}$ three Quarters, The Decimals belonging to theſe, as they are immediate Parts of the whole, are .25 for a Quarter, .5 for an half, and .75 for three Quarters.

But if they be Parts of Parts, other Decimals belong to them, as you ſee in the Tables.

# THE ART OF Practical Meaſuring, &c.

## PART II.

### *The Deſcription of the Rule.*

THIS Rule is different from that deſcribed by Mr. *Coggeſhall*, and which was all along made uſe of in the former Editions, but now is laid aſide, as not being ſo compleat; for his made uſe of both Sides of the Rule in working Proportions, whereas this makes uſe but of one; which is not only a great Advantage in the Performance of the Operations, but alſo reſerves the other Side for the Lines made uſe of in *Scamozzi*'s Architecture, for the ready finding the Lengths and Angles of Rafters, *&c.* Of which more in its proper Place.

Therefore in *Fig.* I. to give a Deſcription of that Side of the Rule, which gives a Solution to all Mr. *Coggeſhall*'s Propoſitions, there is a Piece made to ſlide in and out, having on each Edge thereof a Line of Numbers in two Lengths, *viz.* from 1 at the Beginning to 1 in the Middle, which is eſteemed one Length; and from 1 in the Middle to 10 at the End, the other.

There are alſo adjoining to this Piece two Lines, on one Side, a Line of Numbers in all Reſpects like thoſe juſt deſcribed; and on the other, a Line figured 4, 5, 6, 7, 8, 9, 10, 20, 30, 40, called the Square Line, and when the Meaſure of round Timber is concerned, the Girt Line.

The Lines of Numbers on the ſliding Piece, and that adjoining thereto, are divided between 1 and 2 into 10 Parts, and each Tenth into 5 Parts; between 2 and 3 into 10 Parts, and each Tenth into 2 Parts; from 3 to 4, and from 4 to 5 it's the ſame; from 5 to 6 into 10 Parts only; and ſo on to 1 in the Middle. The ſecond Length or Radius is divided exactly like the firſt.

The Girt Line from 4 to 10 has each Tenth divided into 2 Parts, and from 10 to 40 each Whole into 4 Parts; alſo the Diviſions 37, 38, and 39, with their Halfs and Quarters, are put on before 4 at the Beginning of this Line, and cut, as in their proper Places, towards 40 at the other End of the Line; from whence the Diviſions are carried on to 45, each Diviſion between 40 and 45 being divided into two Parts.

There is on the ſame Side of the Rule but upon the other Leg, a Table, whereby you may know, by Inſpection, what a Load of Timber will amount to at any Price between 6 *d.* and 2 *s.* *per* Foot, reckoning 50 Feet to the Load.

### *Example* 1.

At 9 *d. per* Foot, a Load of Timber will come to 1 *l.* 17 *s.* 6 *d.*

### *Example* 2.

At 10 *d.* ¼ *per* Foot, a Load will amount to 2 *l.* 2 *s.* 8 *d.* ½.

When the Rule is opened, ſo as to become one right Line, you will find that the Back or outer Edge thereof is decimally divided; that is, each Foot is divided into 10 equal Parts, and each Part into 10 more, by which means the Rule is divided into 200 equal Parts; and with this Line I mean Dimenſions ſhould be taken, when I ſpeak of Foot Meaſure.

Next to this outer Edge, on the other Side of the Rule, where *Scamozzi*'s Lines are, is a Line of Inches decimally divided, and conſequently each Inch is divided into 10 equal Parts, which is for Gauging.

*Note*, on the Back-ſide of the ſliding Piece is a Foot Rule, whoſe Inches are divided into Halves, Quarters, and half Quarters.

That Line of Numbers upon the ſliding Rule, with that Line of Numbers which is next to it on the fixed one, is in this Book called the double Scale.

## SECTION I.

### *Of the Line of Numbers, commonly called* Gunter's *Line.*

The proper Numeration of this Line I account, 1 at the Beginning; and ſo by 10 in the Middle, to 100 at the End.

But for the better underſtanding this Line, ſee here the Degrees of Number from Unit on either Side, as they ſtand on the Line; that is, increaſing from left Hand to right.

| *Thouſ. pts.* | *Hund. pts.* | *Ten. pts.* | *Unit.* | *Ten. pts.* | *Hund.* | *Thouſ.* |
|---|---|---|---|---|---|---|
| .001 | .01 | .1 | 1. | 10. | 100. | 1000. |

Where you ſee, how they increaſe on one Side from Unit, and on the other Side decreaſe from the ſame in a tenfold Proportion. So that if you ſet any one of them at the Beginning, the two next following ſhall be, one the Middle, the other the End. As if you call 1 at the Beginning one tenth, the Middle ſhall be 1, and the End 10. If you call one at the Beginning 10, the Middle ſhall be 100, and the End 1000. But if it be not otherwiſe limited, account it, as I ſaid before, 1, 10, 100.

On that Line of Numbers which is on the moveable Rule, at theſe Numbers following may be Pricks, for the more ready finding them; they being firſt Numbers or Centers, as they commonly call them.

At 9 for Yard Meaſure.

At 12 four Points thus . : . for Plank or Board, and Glaſs.

At 144 alſo for Glaſs.

At 160 for Land Meaſure.

At 272, 25, or 272 for Rod Meaſure of Brick-work at 1 ½ Brick thick; for the Decimal .25 equal ¼ may be omitted without conſiderable Error.

At 204 for two Bricks thick, and other Points or Cuts for other Thickneſſes, if deſired. The finding whereof is ſhewed after.

At 282 for Ale Gallon Meaſure in ſquare and oblong Veſſels. And other may be ſupplied, as any hath occaſion for them.

## SECT. II.

### *Of the Square or Girt Line.*

THIS is no more but one whole Length of the Line of Numbers, but at a double Radius, it being exactly equal to the Lines of Numbers on this Rule, which are in two Lengths.

In the Numeration of it, when occaſion requires, you muſt account 10, 20, 30, to be 1, 2, 3; as alſo 4, 5, 6, 7, *&c.* to be 40, 50, 60, 70, *&c.*

At 12 on this Line let there be four Pricks, as at 12 on the Line of Numbers: At 17.15, the Wine Point, marked W. At 18.95, the Ale Point, marked A. Theſe are put on by the Workman.

At 10.635 may be a Point like the Gauge Points, for finding the true Content of a round Solid by the Girt.

At 13.54 ſuch another, for finding the Content of a Cylinder by the Diameter.

At 41.57 another, to ſhew how many Inches in Length make a Foot Solid at any Girt or Square not exceeding 40 Inches.

Theſe may be put on thus:

For the firſt: Set 12 on the ſquare Line to 14 on the Line of Numbers; againſt 11 on the Line of Numbers mark this Point.

The ſecond: Set 12 on the ſquare Line to 11 on the Line of Numbers; againſt 14 on the Line of Numbers mark this Point.

The third: Set 12 on the ſquare Line to 1 at the Beginning of the Line of Numbers; againſt 12 on the Line of Numbers mark this Point.

Theſe, or any other mentioned hereafter, cut with a ſharp-pointed Penknife in two Places, as the Gauge Points, and ſtrike in with your Finger ſome Sallow Coal fine ground with Linſeed Oil, and then wipe the Rule clean.

Both theſe Lines are put on from the Logarithms.

## SECT. III.

### *The general Uſe of double Scales.*

It is chiefly for the working the Rule of Three or having three Numbers given, to find a fourth Proportional, it including Multiplication and Diviſion; for there is no other Difference, than that in theſe two an Unit is one of the three.

To find this fourth: Set the firſt Number on the ſliding Rule to the ſecond on the Line of Numbers on the fixed Rule; againſt the third Number on the firſt of theſe Rules, is the fourth on the ſecond Rule.

*Example.* If 2 give 3, what ſhall 6 give? Set 2 on the firſt to 3 on the ſecond; againſt 6 on the firſt is 9 on the ſecond.

Wherefore when I ſay, ſet 2 to 3, againſt 6 is 9, I mean as in the above-ſet Example, tho' I name not the firſt or ſecond Rule, yet you may note that the moveable Rule is for the moſt Part the firſt.

So in Multiplication, 1 being the firſt Number, ſet one to either of the two Numbers to be multiplied, (beſt to the neareſt) againſt the other is the Product.

In Diviſion, the Diviſor being the firſt Number, ſet it either to one, or to the Dividend, againſt the other is the Quotient. Examples of both you will meet with after.

By this the Arithmetick of the Rule is eaſily underſtood, the firſt Numbers being Diviſors; only where the ſquare Line is uſed, the Numbers on the ſquare Line muſt be ſquared or multiplied by themſelves, and their Squares uſed in every reſpect as if they were the Numbers themſelves, as you will after ſee.

## SECT. IV.

*To ſet the ſquare Line to his Squares, and thereby to ſquare a Number not exceeding* 100, *and to find the ſquare Root of a Number not exceeding* 10,000.

1. SET 10 on the ſquare Line to 1 at the Beginning of the Line of Numbers, both which, if you account 1, you have on the Line of Numbers the Squares from 1 to 20. Alſo at this ſet as is moſt convenient to take the Squares from 100 to 2000, *viz.* by accounting 10 on the ſquare Line 10, and 1 at the Beginning 100.

2. Set 10 on the ſquare Line to one in the Middle, accounting 10 on the ſquare Line 10, and 1 in the Middle 100, you have the Squares on the Line of Numbers from 16 to 1000; and of this you will have moſt Uſe.

3. Set 10 on the ſquare Line to 10 at the End, accounting 10 on the ſquare Line 100, and 10 at the End 10,000; ſo have you on the Line of Numbers the Squares from 1400 to 10,000; and againſt all the Squares, at every Set, his own Root upon the Square or Girt Line.

*Example.* I would know what is the ſquare Root of 380?

Set 10 on the ſquare Line to 1 in the Middle, (according to the ſecond Direction) againſt 380 on the Line of Numbers is 19.5 near.

## SECT. V.

### *A Direction concerning the Shortneſs of the Lines on the Rule.*

1. IN working theſe Proportions on the double Scale, if you uſe half of either the ſecond or third Number inſtead of the whole, you will have half the Content; if you uſe the Half of both, you have only a Quarter of the Content. *Note*, The firſt Number muſt always remain whole.

2. On the ſquare Line: If you uſe half that Number that is on the Line of Numbers, commonly the ſecond, (being ordinarily Lengths or Depths) you have half the Content.

If half of that on the ſquare Line, commonly the third, (being ordinarily Sides of Squares, or Diameters) you have a Quarter of the Content; if you halve them both, you have only one Eighth of the Content.

3. In finding a mean Proportional; half the Extremes give half the Means, and a Quarter gives a Quarter. Theſe may be more exactly defined, and multiplied accordingly.

This Direction alſo may be uſeful to you in working by the ſquare Line, when at any Time the third Number ſtandeth beyond the Line of Numbers; and removing the firſt to the ſecond in the other Length, ſets it farther off. For then,

1. If the firſt be a fix'd Number on the ſquare Line, as 12, and the Gauge Points, *&c.* ſet it to half the ſecond, and double the Content.

2. If the firſt and ſecond be fix'd, as in finding the ſuperficial Content by the Diameter, uſe half the third Number being on the ſquare Line, and quadruple (or multiply by 4) the Content.

Theſe Products are the 4th Numbers ſought.

# THE ART OF Practical Meaſuring, &c.

## PART III.

### PROB. I.

*To meaſure round Timber the common Way.*

MEaſure the Length in Feet and half Feet, and (if the Cuſtom or Agreement be ſo) in Quarters; then back again half way, where girt the Tree with a ſmall Cord or Chalk Line, double this Line twice very even. This fourth Part of the Circuit, (which in this Treatiſe I call the Girt) meaſure in

Inches, halves and quarters of Inches. And this obſerve, that the Lengths be given in Feet, the Girts and Sides of Squares in Inches.

So have you three Numbers given, *viz.* 12 always the firſt, the Length always the ſecond, and the Girt or Side of the Square the third.

To come now to the Rule: Set 12 on the Girt Line to the Length on the Line of Numbers; againſt the Girt on the Girt Line is the Content on the Line of Numbers. And this is the general Rule.

Now there being two Caſes, one when at the firſt Set the Girt is againſt ſome Part of the Line of Numbers, the other when it is not, ſo that 12 muſt be removed, I will give you ſeveral Examples of both, obſerving that the vulgar Fractions before-mentioned, as alſo all Decimals, always follow the Number they belong to before the Name thereof.

## *CASE* I.

## *EXAMPLES.*

1. A Tree is 20 Foot long, and 15 Inches girt, ſet 12 to 20, againſt 15 is 31 ¼ Foot, or 31 Foot and a Quarter.

2. A Length is 8 ½ Foot, the Girt is 35 ¾ Inches, ſet 12 to 8 ½, againſt 35 ¾ is 75 Foot and almoſt an half.

3. A Length is 15 Foot, the Girt 42 ½ Inches, ſet 12 to 15, againſt 42 ½ is 188 Foot.

4. A Rail is 15 Foot long, the Girt 3 Inches, ſet 12 to 15, againſt 3 is 9 Tenths of a Foot, and more.

5. A Length is 9 ½ Foot, the Girt 39 ¾ Inches, ſet 12 to 9 ½, againſt 39 ¾ at the Beginning of the Girt Line is 104 Foot.

6. The Length is 0.*62* Foot, the Girt 35 Inches, ſet 12 to the Decimal .*62* in the firſt Length, againſt 35 is 5 ¼ Foot, which may ſerve for a ſhort Cut of a Tree.

If this Length had been propounded 7 ½ Inches, it muſt have been turned into Foot Meaſure thus: On the double Scale ſet 12 on the ſliding Rule, to 100 on the Line of Numbers on the fixed Rule, againſt the Length in Inches is the Length in Foot Meaſure, equal to .*625* of a Foot; but if it lies before you, meaſure it by the Line of Foot Meaſure on the Rule.

## *CASE* II.

If at the firſt Set the Girt is beyond the Line of Numbers, remove 12 to the Length in the other Length thereof. Which Caſe may alſo happen in Gauging, *&c.*

*Example* 1. The Length is 18 Foot, the Girt 31 Inches; ſet 12 to 18 in the firſt Length, againſt 31 is 120 Foot.

2. A Rail is 15 Foot long, the Girt 3 ½ Inches; ſet 12 to 15 in the firſt Length, againſt 3 ½ is ¼ Foot, and a little more, *viz.* 1.27 Foot.

3. A Wrong is *6* ½ Foot long, and 4 ¼ in Girt; ſet 12 to *6* ½ in the ſecond Length, againſt 4 ¼ is above eight Tenths of a Foot. Theſe Examples may be ſufficient.

### *Note* 1.

If you would find the Content of a great Piece of Timber immediately in Loads, at 40 Foot to the Load, uſe half the Girt inſtead of the whole. *Example*. A Length is 15 Foot, the Girt 42 ½ Inches; ſet 12 to 15, againſt 21 ¼ is 47, whereof the 4 is 4 Loads, and the 7 is 28 Foot.

If by this Way you meaſure Timber, whoſe Girt is above 40 Inches, as alſo the Piece in *Caſe* 1. *Ex.* 5. which, without the ſaid Subdiviſions, and placing 38 and 39 before 4 at the Beginning, are not reſolved by the general Rule.

But if you would have the Content of theſe Pieces in Feet, multiply the Content found by 4, the Square of 2, by which you divided your Girt; ſo 47 multiplied by 4 is 188 Foot.

### *Note* 2.

To what Length ſoever you ſet 12, 17 will ſtand to the Double thereof, $8\frac{1}{2}$ to Half thereof, both a little over; alſo 24 will ſtand to the Quadruple thereof, and 6 to a Quarter thereof exactly; and the ſame Proportion the Content bears to the Length at any of theſe Girts, *viz.* at 17 Inches Girt, the Content is double to the Length; at $8\frac{1}{2}$ Inches Girt, the Content is but half the Length, &c.

### *Note* 3.

If you would find theſe Contents by natural Arithmetick, ſeeing 12 and the Girt, *viz.* the firſt and third Numbers are on the ſquare Line, according to a Hint given in *Sect.* 3. of *Part* 2. multiply the Square of the Girt by the Length, and divide the Product by 144, the Square of 12, which is your conſtant Diviſor, the Quotient is the Content.

So in *Ex.* 1. *Caſe* 1. the Square of 15, *viz.* 225, multiplied by 20, and the Product 4500, divided by 144, the Square of 12, the Quotient is 31.25, the Content.

By the Logs. to this general Log. 7.84164, add the Log. of the Length and the Log. of the Girt twice; the Sum is, The Log. of the Content.

| | |
|---|---|
| *Gen. Log.* | 7.84164 |
| 20 | 1.30103 |
| 15 | 1.17609 |
| | 1.17609 |
| 31.25 | 1.49485 |

## PROP. II.

### *True Meaſure of round Timber or Stone by the Girt.*

BEcauſe this common Way of meaſuring round Timber giveth not a true Content, but always too little, (tho' it ſtill be generally uſed) I have given you a Point, and ſhewn how you may put it on the Rule, which ſetting to the Length inſtead of 12, the Girt ſhall point you out a true Content, accounting it a Cylinder, as the ſaid common Way alſo doth.

*Example.* Let the Length be 10 Foot, the Girt 15 Inches; ſet the ſaid Point mark'd at 10, 635 on the Square or Girt Line (which you may call the true Point) to 10; againſt 15 you have 20 Foot leſs by about one Tenth; whereas the common Way giveth but 15 Foot, and a little above an Half.

The general Logarithm anſwering this Point is 7.94652, to be uſed as before.

Thus far by the Length and Girt: I ſhall only add, that the common Meaſure is to the true as 11 to 14; ſo that if you ſet 11 on the double Scale to any Number of Feet or Loads meaſured the common Way, 14 ſhall point to the true Content of the ſame; and if you ſet 14 to any true Content, againſt 11 is the Content the common Way.

## PROP. III.

### *Having the Length of a Cylinder in Feet, and the Diameter in Inches, to find the Content in Feet.*

SET the Point 13.54 to the Length, againſt the Diameter is the Content. *Example.* Let the Length be 10 Foot, and the Diameter 20 Inches, ſet 13.54 to 10, againſt 20 is 21.82 Foot; the general Log. is 7.73676, to be uſed as before.

## PROP. IV.

### *Having the Length of a ſquare Solid in Feet, and the Side of the Square in Inches, to find the Content in Feet.*

SET 12 to the Length, againſt the Side of the Square is the Content. The Caſes are as in round Timber; the Examples alſo will ſerve, accounting the Girts to be Sides of Squares.

## PROP. V.

### *To find a mean Proportional between two Numbers.*

SET the greater of the two Numbers on the ſquare Line to the ſame on the Line of Numbers, againſt the leſs on the Line of Numbers is the mean Proportional on the ſquare Line.

Or ſet the leſs on the ſquare Line to the ſame on the Line of Numbers, againſt the greater on the Line of Numbers is the mean Proportional on the ſquare Line. One of theſe will not fail. Examples follow in the next.

# PROP. VI.

## *Unequal ſquared Solids.*

MEaſure the Length in Feet, the Breadth and Depth in Inches; then find a mean Proportional between the Breadth and Depth, as is taught above; and it will be the Side of a Square equal to the Baſe or End; which having found, meaſure the Piece as ſquare Timber.

*Example* 1. In Timber, whoſe Length let be 10 Foot, the Breadth 21 Inches, the Depth $8\frac{1}{2}$ Inches; ſet 21 to 21, againſt $8\frac{1}{2}$ on the Line of Numbers is 12.36, or 13 a Quarter and half Quarter near; or ſet $8\frac{1}{2}$ to $8\frac{1}{2}$, againſt 21 on the Line of Numbers is the ſaid 13.36; then ſetting 12 to 10, againſt 13.36 is 12.4 Foot.

*Example* 2. In Stone, which let be 6.35 Foot long, $36\frac{1}{2}$ Inches broad; and 5.7 Inches deep; ſet $36\frac{1}{2}$ to the ſame, againſt 5.7 on the Line of Numbers is 14, and ſomething ſhort of an half; then ſet 12 to 6.35, againſt this Mean is 9.2 Foot near.

This Mean, in Caſe of a Fraction, ſhall give you no Trouble; for if with a Pencil, Chalk, or any thing that may be wiped out without Damage to your Rule, (let it not be Ink) you make a fine Mark on the ſquare Line at this Mean, and then ſet 12 to the Length, this Mark, without defining it, ſhall point out your Content.

## PROP. VII.

### *Solids of a Triangular Baſe.*

FIND a mean Proportional between the Baſe and half the Perpendicular, or between the Perpendicular and half the Baſe, both meaſured in Inches; this Mean is the *Side* of a Square equal to the Triangle; then ſet 12 to the Length in Feet, againſt this Side is the Content.

If two Sides of a Triangle be equal, the unequal Side may be the Baſe; if the three Sides be unequal, the longeſt Side is commonly the Baſe; from whence the neareſt Diſtance to the oppoſite Angle is the Perpendicular.

## PROP. VIII.

### *Solids whoſe Baſes have many equal Sides and equal Angles.*

THESE Baſes are regular Figures: Having the Length in Feet, and a Side in Inches, get the Perpendicular from the Center to a Side alſo in Inches; ſo ſhall the mean Proportional between the Perpendicular and half the Sum of the Sides be the Side of a Square equal to the Baſe; which having found, meaſure it as ſquare Timber.

*Example.* A Piece of Timber of eight Sides is 10 Foot long, the Side 12 Inches, the Perpendicular 14.48 Inches, which you may call 14½; ſet 14½ to 14½, againſt 48, half the Sum of the Sides on the Line of Numbers, is 26.4 on the ſquare Line, or there make a Mark; then ſet 12 to 10, againſt this Mark is 48 Foot, and a little more than a Quarter.

And thus much of theſe Ways of Timber Meaſure, which being the main Occaſion of the Rule, and not depending on any thing which followeth, I have ſet in the firſt Place.

## PROP. IX.

### *Having the Girt, to find the Side of the Square equal near.*

THIS and the two following Propoſitions are wrought on the double Scale, yet I have here adjoined them for their Affinity with Timber Meaſure, and the proportional Numbers given in them are ready cut on the Rule, and give Contents to an Exactneſs ſufficient in any Concerns of Timber.

As 7. to 7.9, ſo the Girt to the Side of the Square equal: Let the Girt be 15 Inches on the double Scale, ſet 7. to 7.9, againſt 15 is 16.9 near: If you ſet 12 to the Length in Feet, this Side ſhall point out a true cylindrical Content.

## PROP. X.

### *Having the Girt, to find the Side of the Square within near.*

AS 10 to 9, ſo the Girt to the Side of the Square within near. *Example.* Set 10 to 9, againſt 15 is 13$\frac{1}{2}$; and ſo much will ſuch a Piece bear ſquare.

By which you may know, before a Piece be hewn, how many whole Boards or Planks, of any Thickneſs, may be had out of it.

From hence alſo you may ſee, that the Girt, tho' leſs than the Side of the Square equal, yet is greater than the Side of the Square within; toward which moſt Timber is hewn before it can ſerve to any ſquare Uſes; which may be one Reaſon of the Continuance of the ſaid common Way; of which Opinion I find alſo Mr. *Henry Philips* to be, in a Treatiſe on this Subject.

## PROP. XI.

*Having the Diameter, to find the Side of the Square within near.*

AS .1 to .707, or to excuſe a Cut there, as 8.5 to 6, (being Points equivalent near) ſo the Diameter to the Side of the Square within near.

Let the Diameter be 19.1, *viz.* the Diameter of 60 Inches Circumference; ſet 8.5 to 6, againſt 19.1 is 13.5 near.

## PROP. XII.

*To find how many Inches in Length make a Foot Solid, at any Girt or Side of Square not exceeding 40 Inches.*

SET the Girt or Side of the Square on the ſquare Line to 1 at the Beginning of the Line of Numbers, againſt 41.57 are the Inches which make a Foot.

So if you ſet *6*, for Example, to 1, againſt 41.57 is 48, and ſo many Inches in Length make a Foot at ſix Inches Girt or Side of Square.

And now having done with the Meaſure of ordinary Timber, let me advertiſe any Reader that hath not ſeen much meaſured, that ſometimes he will find a great Difference in the Girt of a Tree in the Space of a Foot, more or leſs, for the moſt Part where one or more Arms have been cut off; in ſuch Caſe it is neceſſary to girt the Tree twice, nay thrice if there be Cauſe, otherwiſe there will be Loſs to Buyer or Seller.

Alſo they ſay, the Buyer hath Privilege to girt any where between the Middle and the Ground End, if it be for his Advantage.

## PROP. XIII.

### *True Meaſure of a Solid that tapereth ſtrait.*

MEaſure the Length in Feet; note alſo the third Part, which you may find by ſetting 3 on the double Scale to the Length; againſt 1 is the third Part. If the Solid be round, meaſure the Diameters at each End in Inches; ſubtract the leſs Diameter out of the greater; half the Difference add to the leſs Diameter; the Sum is the Diameter in the Middle of the Piece.

1. Set 13.54 to the Length, againſt the Diameter in the Middle is a fourth Number.

2. Set 13.54 to the third Part of the Length, againſt half the Difference is a fourth Number; both theſe fourth Numbers added together make the Content.

*Example.* Let the Length be 18 Foot, the third Part is 6; let the greater Diameter be 24, the leſs 16, the Difference is 8; half the Difference 4 added to the leſs Diameter 16, the Sum 20 is the Diameter in the Middle.

Set 13.54 to 18, againſt 20 is 39.27. 39.27
Set 13.54 to 6, againſt 4 is .524, which .524
added to 39.27, maketh 39.794, or 39 39.794
Foot and above 3 Quarters.

*Note*, That 13.54 muſt be ſet to 6 in the ſecond Length, as in the ſecond Caſe of round Timber-Meaſure the common Way.

If the Solid be ſquare, uſe the Sides of the Squares at each End in every Reſpect as the Diameters,

meters, meaſuring them in Inches, &c. but let 12 be your firſt Number.

If it be any other regular Figure, uſe the Sides of the Squares equal to each Baſe (found as is before ſhewn) as the other, taking alſo 12 for your firſt Number.

## PROP. XIV.

### *The Meaſure of a Shell or Flitch of Timber.*

IF a Piece be taken out of the Middle of a round Piece of Timber from End to End, there will be left two Pieces, which they call Shells or Flitches.

To find a near Content of theſe after the common Way with little Trouble, meaſure the Length in Feet, the round Part, and the Thickneſs in the Middle (taken with a Pair of Calepers) in Inches.

Theſe two, with a third Part of the Thickneſs, add together, a fourth Part whereof account your Girt, and meaſure as round Timber the common Way.

If on the double Scale you ſet 3 to 4, againſt the Thickneſs is itſelf, with a third Part added to it.

*Example.* Let the Length be 30 Foot, the round Part 25.3 Inches, the Thickneſs 7.2 Inches, ſet 3 to 4, againſt 7.2 is 9.6, which added to 25.3, maketh 34.9, the fourth Part whereof is 8.7 near.

Or prick the ſaid 9.6 on the flat Part in the Middle from one Side, and keeping the End of your Line at the other, girt the whole round Part, and to the ſaid Prick; double the Line twice, and meaſure it in Inches for your Girt.

Set 12 to 30, againſt 8.7 is 15 Foot and three Quarters.

*Note*, That this holds not ſo well in Sections cut far from the Middle of the Piece; in others it giveth a Content ſomewhat leſs than the common Way, which may the better be born with, becauſe there is more Loſs in theſe than in other Pieces; and as they fall ſhort of the middle Pieces in Value, ſo a leſs exact Meaſure may ſerve.

## PROP. XV.

### *Having the Diameter, to find the Area or ſuperficial Content of the Circle.*

SET 1 on the ſquare Line to .7854, or to excuſe a Cut there, ſet 11 to 9.5, againſt the Diameter is the ſuperficial Content.

*Example.* Let the Diameter be 1.7 Foot, ſet 11 to 9.5, againſt 1.7 is 2.27 Foot near.

By the Logs. to the Log. of the Diameter twice add this Log. 9.89509, being the Log. of the Decimal .7854. the Sum is the Log. of the ſuperficial Content.

| | |
|---|---|
| 1.7 | 0.23045<br>0.23045 |
| .7854 | 9.89509 |
| 2.27 | 0.35599 |

*Note*, That if the Diameter exceed not 3.57, 1 in the Middle is but 1; but if it exceeds 3.57, 1 in the Middle is 100.

Here you may have occaſion to make uſe of the Direction given in *Sect.* 5. *Part* 2.

Hence it is as eaſy, having the ſuperficial Content, to find the Diameter, or to caſt any Number into a Circle, ſo may the Gauge Points be put on, for they being the Diameters of Circles, whoſe Area's are equal to the Number of Cubick Inches in the Gallon of Wine or Ale reſpectively, if you ſet the Rule as above, you will ſee the Wine Point ſtand againſt 231, and the Ale Point againſt 282.

## PROP. XVI.

### *Caſk Gauging.*

THE Figures of theſe Veſſels being uncertain, the Staves of ſome being more circular from Head to Bung, and ſo more capacious than other, the late Gaugers diſtinguiſh them into four kinds; the Sphæroid, whoſe Staves are moſt arching, and this contains moſt; the Conick, whoſe Staves from Head to Bung are ſtrait, (if any ſuch can be made) and this contains leaſt; the Parabola, whoſe Staves are arching, but nearer to the Sphæroid than to the Conick; the Conoid, whoſe Staves are arching, but nearer to the Conick than to the Sphæroid; all theſe may have the ſame Dimenſions of Length and Diameters, yet differ conſiderably in the Contents

Mr. *Everard* in his abſolute Piece, *Stereometry made eaſy*, printed 1684, giveth a Diagram of all the Kinds, and Rules for each, both by Arithmetick and the ſliding Rule, except for the Conick, there being (as he ſaith) none ſuch made; yet the Figure thereof is uſeful to the diſtinguiſhing the other.

Mr. *Wingate* took no Notice of theſe ſeveral Kinds; his general Way applied to this Rule is thus:

Meaſure the Length of the Veſſel within, the Diameter at the Bung, and the Diameter at the Head in Inches and Tenths, ſubtract the Diameter of the Head out of that of the Bung, the Difference multiply by 7, and divide the Product by 10 on the Rule eaſily thus; on the double Scale ſet 10 to the Difference, againſt 7 is the Quotient, which is 7 Tenths of the Difference.

Theſe added to the leſs Diameter, the Sum is an æquated Diameter.

Then ſet the Gauge Point, whether of Wine or Ale, to the Length, againſt the æquated Diameter is the Content in Gallons.

Mr. *Everard* agreeth with Mr. *Wingate* upon 7 Tenths near for ten Inches Difference of Diameters, and accounts them to the Sphæroid; in other Differences of Diameters they differ more.

His Numbers for 10 Inches Difference are; for the Sphæroid 7.01, for the Parabola 6.39, for the Conoid 5.62.

In other Differences the Rule differs ſomething from his Table, to which I refer you.

To find the Content of a Caſk in all theſe Kinds; let the Length be 34.5, the Diameter at the Bung 29.4, that at the Head 25.3, this deducted out of that at the Bung, the Remainder or Difference is 4.1.

Set 10 to 4.1, againſt 7 is 2.87 for the Sphæroid; againſt 6.39 or 6.4 is 2.62 for the Parabola; againſt 5.62 is 2.3 for the Conoid.

Theſe added ſeverally to 25.3, the Sum is 28.17 for the Sphæroid, 27.92 for the Parabola, 27.6 for the Conoid, for æquated Diameters.

*Example.* Set the Ale Point to 34.5, againſt 28.17 is 76.25 Gallons for the firſt; againſt 27.92 is 74.9 Gallons for the ſecond; againſt 27.6 is 73.2 Gallons for the third; ſuch is the Difference (upon account of their Shape) by theſe Numbers.

By the Logs. to this general Log. 7.53148 for Wine, to this 7.44484 for Ale, add the Log. of the Length, and the Log. of the æquated Diameter twice, the Sum is the Log. of the Content, as you ſee here for Wine.

| | |
|---|---|
| *Gen. Log.* | 7.53148 |
| 34.5 | 1.53782 |
| 28.17 | 1.44979<br>1.44979 |
| 93.08 | 1.96888 |

The Fractions are thus reduced to Pints; on the double Scale ſet 10 to 8, againſt the Decimal are the Pints anſwering.

The Sphæroid may be known by the round ſwelling of the Staves from one Head to another. If you lay a ſtrait Rule on the Hoops of a Cask from the Head toward the Bung, and it toucheth, or very near, the Hoop next the Head, and that next the Bung, you may account it a Conoid; if the Rule librate upon the middle Hoops, like the Beam of a Ballance, and yet the Staves not much ſwelling, account it a Parabola.

Beſides the Shape of theſe Veſſels, I have obſerved two Things, not noted by any to my Knowledge, which may render the gauging them uncertain; one is, the joining Staves of unequal Thickneſs, not taking Care to ſmooth them within, which may cauſe an Error of ſome Tenths in taking the Bung Diameter.

The other this; the Head Diameter may be taken too great, tho' taken without, by reaſon of the paring away, and ſmoothing the inward Side of the Cask at each End, in order to the putting in the Heads; ſo that in reaſon it ſhould exceed the Diameter pointed out by the Staves, which is the true Diameter: Both theſe I have ſeen in Casks that have been cut aſunder.

## PROP. XVII.

### *Gauging and Inching of Tuns.*

THESE are of ſeveral Figures, but moſt are ſquare or round.

The ſquare are either equal ſided or unequal, both right-angled, and may be conſidered as the ſame.

The round are either cylindrical, *viz.* having the Diameters at Top and Bottom equal (if any ſuch can be hoop'd) or conical, whoſe Diameters at the Top and Bottom are unequal.

Alſo the Content may be required, either total, or only of ſome Liquor contained in them.

The Content is ordinarily found firſt in Ale Gallons, which are reduced to Beer Barrels, by dividing the Number of Gallons by 36, or to Ale Barrels, by dividing the ſame by 32; alſo a Barrel containeth 4 Firkins; ſo 9 Gallons of Beer, 8 Gallons of Ale make a Firkin; the Dimenſions, *viz.* Lengths, Breadths, Depths, and Diameters, are taken in Inches.

## SECT. I.

### *Square Tuns.*

ON the double Scale ſet 282 (cut on theſe Rules) to either Length or Breadth, againſt the other is the Content in Gallons at 1 Inch deep, which being reduced to Firkins and Barrels, as it will bear, by a continual Addition, as we add Pounds, Shillings, and Pence, a Table may be made to any Number of Inches deep.

Or if you ſet 1 on the ſaid Scale to any Depth in Inches of this Content, againſt the other is the total Content; or multiply them by the Pen.

*Example.* The Length is 84 Inches, the Breadth 62 Inches, ſet 282 to 62, againſt 84 in the firſt Length is 18,47 Gallons, or 2 Firkins, 2 Gallons, and near an half of Ale, which you may add, as in the Margin.

| *In.* | *B.* | *F.* | *G.* | *Pts* |
|---|---|---|---|---|
| 1 | 0 | 2 | 2 | 47 |
| 2 | 1 | 0 | 4 | 94 |
| 3 | 1 | 2 | 7 | 41 |
| 4 | 2 | 1 | 1 | 88 |
| 5 | 2 | 3 | 4 | 35 |
| 6 | 3 | 1 | 6 | 82 |
| 7 | 4 | 0 | 1 | 29 |

Let the Depth be 26 Inches, ſet 1 to 18.47, againſt 26 is 480.22, which is near a Quarter.

By the Logs. To this general Log. 7.54975 add the Logs. of the Length and Breadth, the Sum is the Log. of the Content at 1 Inch deep; and if to this you add the Log of the Depth, the Sum is the Log. of the whole Content; or if to the ſaid general Log. you add the Logs. of the Length, Breadth, and Depth, the Sum is the Log. of the whole Content, without Notice of the Content at 1 Inch deep.

| | |
|---|---|
| *Gen. Log.* | 7.54975 |
| 84. | 1.92428 |
| 62. | 1.79239 |
| 18.47 | 1.26642 |
| 26. | 1.41497 |
| 480.2 | 2.68139 |

Becauſe it is likely there will be Tenths of an Inch wet, on the double Scale ſet 10 to the Content in Gallons at 1 Inch deep, againſt every Tenth is his own Share, or Part of the ſaid Gallons. Let the Tenths be 6, ſet 10 to 18,47, againſt 6 is 11 Gallons, belonging to 6 Tenths. They put no Pints into the Table.

## SECT. II.

### *Cylindrical Tuns.*

*Having the Diameter of a cylindrical Tun in Inches, to find the Content in Ale Gallons at 1 Inch deep.*

IF the Diameter exceed not 40 Inches, ſet the Ale Point to 1 in the Middle, againſt the Diameter is the Content, 1 in the Middle being one Gallon.

If the Diameter be above 40 Inches, ſet the ſaid Point to 10 at the End, againſt the Diameter is the Content, 1 in the Middle being 10 Gallons.

Which Contents, being for 1 Inch deep, may be firſt reduced, and then added continually for a Table; or before it be reduced, multiplied by the Depth for a total Content.

Or ſet the Ale Point to the Depth, againſt the Diameter is the total Content.

*Example.* Let the Diameter be 58 Inches, ſet the Ale Point to 10 at the End, againſt 58 is 9.37 Gallons, the Content at 1 Inch deep; let the Depth be 36 Inches, ſet the ſaid Point to 36, againſt 58 is 337.3 Gallons; or multiply the Depth and Content at 1 Inch deep by the Rule or Pen.

By the Logs. To the gen. Log. for Ale, add the Log. of the Diameter twice, the Sum is the Log. of the Content at 1 Inch deep.

And if you uſe the Log. of the Depth, as in the former Section, you will have the whole Content.

| | |
|---|---|
| *Gen. Log.* | 7.44484 |
| 58. | 1.76343 |
| | 1.76343 |
| 9.37 | 0.97170 |
| 36. | 1.55630 |
| 337.3 | 2.52800 |

## SECT. III.

### *Conical Tuns.*

1. TO find the whole Content; proceed as in the Meaſure of a Solid that tapereth ſtrait, *Prop.* 13, only meaſure the Depth alſo in Inches, and inſtead of the Point at 13.54, uſe the Ale Point, as alſo the general Log. uſed in the Section next above, which belongeth to it.

2. But in order to inching them; in ſmall ones and Keelers, they uſe only the Diameter in the Middle, and account them as Cylinders; but in the larger they take one in the Middle of every ten Inches, (beginning at the Bottom) as alſo in the Middle of the remaining Inches, except they be few, for then they account them to the laſt ten,

and take the Diameter in the Middle; theſe Tens alſo they account as Cylinders.

3. Having found the Content anſwering the Diameter next the Bottom, as is ſhewn *Sect.* 2. put it into Firkins and Barrels, as it will bear, and by a continual Addition (as in *Sect.* 1.) make up the ſaid ten Inches.

Then add the Content anſwering the next Diameter ſo reduced, Inch by Inch to the laſt Sum, and ſo proceed till you have finiſhed.

4. In a regular Tun; having the Diameters at Top and Bottom, and the perpendicular Depth, you may find any intermediate Diameter thus.

Divide the Difference of Diameters by the Depth, the Quotient multiply by any Diſtance from the greater Diameter, and ſubtract the Product from the ſaid Diameter, the Remainder is the Diameter at that Diſtance; or multiply the Quotient by any Diſtance from the leſs Diameter, and add the Product to the ſaid Diameter, the Sum is the Diameter at that Diſtance.

5. If the Tun be not exactly round, meaſure two Diameters where you obſerve the Inequality; add them together, and take the half; let the ſaid two Diameters be the longeſt and ſhorteſt, which will croſs one another near at right Angles.

6. Becauſe moſt large Tuns are fixed, and that dripping, for the better Deſcent of the Liquor, the ſquare ones for the moſt Part corner-wiſe, and the Crowns or Bottoms of the round ones commonly uneven and irregular, I adviſe you to fill up the ſaid Crowns or Bottoms, as alſo the Crowns of Coppers, by Meaſure, till they be wholly covered.

Which may be done by a Veſſel of known Quantity, or you may gauge one or a Pail, or by a true Gallon, (for making which Directions are after given, which may alſo be otherwiſe ſerviceable) or in large Tuns beſt of all by both Veſſel or Pail and

Gallon,

Gallon, uſing the Veſſel firſt, and when near covered, the Gallon.

7. When the Bottom is covered, aſſign the gauging Place, (where the Water covers a whole Inch, if it may be; if not, make it up by Meaſure) and fix it by a Mark, and note the wet Inches; mark alſo the Ends of the Diameters at the Superficies of the Water, as alſo the Perpendicular, or neareſt Diſtance of the Top of the Staff from the Water, where the Diſtance is leaſt, and the Length of the Staff from the Water in the ſame Place; of all which having taken an exact Account, let out the Water, and from the aforeſaid Marks begin the Meaſure of your ſeveral 10 or 12 Inches, and to the Quantity before meaſured in, add your Contents Inch by Inch; the Content will be exact enough, if you take a Diameter in the Middle of every 12 Inches.

8. Theſe ſeveral 10 or 12 Inches being underſtood to be of the perpendicular Depth, to avoid an Error, which in ſome Caſes may be conſiderable, on the double Scale ſet the perpendicular Depth to the Length of the Staff, againſt any Number of the ſaid Depth is the Number anſwering on the Staff, which is always greater than that of the Depth.

9. The proportional Parts of any Content belonging to any Diameter, found as before, are to be ſet down, every Part againſt its own Tenth, in a Column by themſelves, againſt the Contents of the whole Inches, to be uſed for the Parts, which for the moſt Part happen to be over and above the whole Inches.

10. Reduce not the Decimals of a Gallon (the Addition of them being eaſy, and becauſe they make not their Table to Pints) except in the proportional Gallons.

11. The Diameters, whether long or ſhort, are meaſured by ſliding Rules, numbered in Inches as

they are drawn out, (or in Gallons, which will ſave you ſome Trouble) and are made to ſet together (ſo as to be portable) to a great Length.

What hath been ſaid of theſe Tuns, may be underſtood of Coppers, Coolers, or any other Veſſels uſed for Wort, either round or ſquare.

12. In an oval Tun; find a mean Proportional between the longer and ſhorter Diameter, it is the Diameter of a Circle equal to the Oval.

13. As for a true Gallon; to any Diameter in Inches which you chuſe, find the Content in Inches, (as *Prop.* 15.) by which divide 231 or 282 for Wine or Ale reſpectively, the Quotient found to the hundredth Part of an Inch, is the Depth. *Example*, the Diameter is 6 Inches.

The ſuperficial Content anſwering is 28.27, by which dividing 231, the Quotient is 8.17, the Depth of the Wine Gallon, by which again dividing 282, the Quotient 9.97 is the Depth of the Ale Gallon.

If you would have it ſquare, divide the ſaid two Numbers by the Square of the Side in Inches; let the Side be 5 Inches, by 25 divide 231, the Quotient 9.24 is the Depth of the Wine Gallon; and again, by 25 divide 282, the Quotient 11.28 is the Depth of the Ale Gallon.

## PROP. XVIII.

### *To gauge a Stand.*

IT may be accounted a cloſe conical Tun, and meaſured as a Solid that tapereth ſtrait, *Prop.* 13. only (as in the conical Tun) meaſure the Depth alſo in Inches, and inſtead of the Point 13.54 uſe the Gauge Points, and the general Log. belonging to them; as in this Example in Ale.

Let the Depth be 33 Inches, a third Part thereof is 11; let the greater Diameter be 30 Inches, the leſs 24 Inches, the Difference is 6, the half-Difference 3, which added to the leſs Diameter, the Sum 27 is the Diameter in the Middle.

1. Set the Ale Point to 33, againſt 27 is 67 Gallons.

2. Set the ſaid Point to 11, againſt 3 is .27, or about a Quarter of a Gallon; ſo the Content of the Stand is 67.27 Gallons.

So little is the Difference between the exact Content, and that found by the Diameter in the Middle.

## PROP. XIX.

*To enlarge or diminiſh a Circle, Square, or other regular Figure at a Rate given.*

THE Proportion (reſpecting the Rule) is, as one Term of the Rate to the Square of the Diameter or Side given, ſo the other Term to the Square of the Diameter or Side required; therefore the Root thereof is the Diameter or Side demanded.

Alſo if you would enlarge, the leſs Term of the Rate is firſt; if you would diminiſh, the greater is firſt.

*Example* 1. If 1000 Men lodge in a Square whoſe Side is 60 Paces, how many Paces ſhall the Side of a Square be wherein 5000 Men may ſo lodge?

Here the ſecond Number being on the firſt or moveable Rule, it is moſt convenient to ſet 60 on the ſquare Line to 1000 in the Middle of the Line of Numbers, againſt 5000 on the Line of Numbers is about 134, and ſo many Paces muſt the Side be.

*Example* 2. I would diminiſh a Circle, whoſe Diameter is 10 Foot, at the Rate of 8 to 5; ſet 10 on the ſquare Line to 8 on the Line of Numbers, againſt 5 on the Line of Numbers is 7,9 Foot, the Diameter required.

## PROP. XX.

*Having the Dimenſions of the Parts of a Ship, which make the Faſhion or Shape, together with the Burthen thereof, to find the Dimenſions of the ſaid Parts for a Ship of any other Burthen, greater or leſs, retaining the Faſhion or Shape of the given Ship.*

THIS Propoſition I find in Mr. *Norwood*, but wrought with great Trouble. Since the Invention of the Logarithms by the Lord *Napier*, (whoſe Name will never be forgotten) it is performed with great Eaſe, either by the Line of Numbers, with a Cube Line, being a Line of a triple Radius adjoined, or moſt exactly by the Logs. for want of the aforeſaid Cube Line, take this way by Compaſſes on the Line of Numbers.

Divide the Space between the Burthen given and that required into three equal Parts, with this Extent, ſet one Foot of the Compaſſes on each of the given Dimenſions, *viz.* the Length of the Keel, Length of the Midſhip Beam, and Depth of the Hold, *&c.*

And if the Burthen required be greater than that given, turn the other Foot forward to a greater Number; if leſs, turn it backward to a leſs Number, and they will be the reſpective Dimenſions required in Feet and Tenths.

*EXAMPLE.*

## EXAMPLE.

| The Burthen given | 100 Tun. | Required 280 Tun. |
|---|---|---|
| | F. | F. |
| Length of the Keel | 50.5 | 71.2 |
| Len. of the Midſhip-beam | 21. | 29.6 |
| Depth of the Hold | 9. | 12.7 |
| Raking forw. of the Stem | 13.5 | 19. |
| Raking backw. of the Stern | 4. | 5.6 |

By the Logs. ſubtract the Log. of the leſs Burthen from the Log. of the greater, the Difference divide by 3; the Quotient or third Part add to or ſubtract from the Logs. of the ſeveral Dimenſions of the given Ship, according as the Burthen required is greater or leſs than the given; the Sums or Remainders ſhall be the Logs. of the Dimenſions for the Burthen required.

This, holding true in the Dimenſions of Maſts, Yards, Cables, Anchors, &c. muſt needs be of great Uſe, being ſo eaſily wrought, eſpecially to the Shipwright, it freeing him from groſs Error; and by it he may be inſtructed to provide and order his Materials to the beſt Advantage.

## *To Gauge a Cask which is not full.*

### A TABLE for gauging of Wine Casks which are not full.

| G. | parts | G. | parts | G. | parts | G. | parts | G. | parts |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 000 | 13 | 2630 | 26 | 4330 | 39 | 5913 | 52 | 7672 |
| 1 | 295 |  | 2703 |  | 4400 |  | 5976 |  | 7758 |
| 2 | 470 | 14 | 2775 | 27 | 4462 | 40 | 6040 | 53 | 7829 |
| 1 | 602 |  | 2847 |  | 4542 |  | 6094 |  | 7909 |
|  | 720 | 15 | 2918 | 28 | 4585 | 41 | 6158 | 54 | 7990 |
| 2 | 830 |  | 2986 |  | 4646 |  | 6223 |  | 8072 |
| 3 | 935 | 16 | 3056 | 29 | 4706 | 42 | 6288 | 55 | 8154 |
|  | 1038 |  | 3123 |  | 4766 |  | 6353 |  | 8236 |
| 4 | 1138 | 17 | 3189 | 30 | 4826 | 43 | 6418 | 56 | 8319 |
|  | 1235 |  | 3255 |  | 4885 |  | 6483 |  | 8404 |
| 5 | 1329 | 18 | 3321 | 31 | 4943 | 44 | 6548 | 57 | 8491 |
|  | 1420 |  | 3387 |  | 5000 |  | 6613 |  | 8580 |
| 6 | 1502 | 19 | 3452 | 32 | 5057 | 45 | 6679 | 58 | 8661 |
|  | 1596 |  | 3517 |  | 5115 |  | 6745 |  | 8765 |
| 7 | 1681 | 20 | 3582 | 33 | 5174 | 46 | 6841 | 59 | 8862 |
|  | 1764 |  | 3647 |  | 5234 |  | 6877 |  | 8962 |
| 8 | 1846 | 21 | 3712 | 34 | 5294 | 47 | 6944 | 60 | 9065 |
|  | 1928 |  | 3777 |  | 5354 |  | 7012 |  | 9170 |
| 9 | 2010 | 22 | 3842 | 35 | 5415 | 48 | 7082 | 61 | 9280 |
|  | 2091 |  | 3906 |  | 5476 |  | 7153 |  | 9398 |
| 10 | 2171 | 23 | 3960 | 36 | 5535 | 49 | 7225 | 62 | 9530 |
|  | 2242 |  | 4024 |  | 5600 |  | 7297 |  | 9705 |
| 11 | 2328 | 24 | 4087 | 37 | 5662 | 50 | 7370 | 63 | 10000 |
|  | 2405 |  | 4154 |  | 5724 |  | 7444 |  |  |
| 12 | 2481 | 25 | 4213 | 38 | 5787 | 51 | 7519 |  |  |
|  | 2556 |  | 4270 |  | 5850 |  | 7595 |  |  |

The

## The Uſe of the TABLE.

FIND the Content of the whole Cask, and the Depth of the Liquor therein, being the wet Part of the Bung Diameter, the Axis of the Veſſel being horizontal or level; as the Diameter at the Bung in Inches to the Depth of the Liquor, ſo 10,000, the Radius of the Table, to the proportional Part; find in the Table the ſaid Parts, or neareſt, and note the Gallons and Parts anſwering; then as 63, the Gallons in a Wine Hogſhead, to the Gallons noted, ſo the Content of the whole Cask to the Content of the Liquor in the Cask.

# THE ART OF Practical Meaſuring, &c.

## PART IV.

### *The Uſe of the double Scale of Numbers in ſome ſuperficial Meaſures and Accounts.*

*Directions.*

1. IN the Rule of Three direct. If the ſecond Number be greater than the firſt, the fourth ſhall be greater than the third; and on the contrary.

But in the inverſe Rule, if the ſecond be greater than the firſt, the fourth ſhall be leſs than the third; and on the contrary.

2. If ſetting the firſt to the ſecond, the third reacheth beyond the Line, either remove the firſt to the ſecond in the other Length of the ſecond Line, or take the third Number in the other Length of the firſt Line.

3. The ſecond and third Numbers are never taken both on the ſame Line.

4. Obſerve well what Number goeth with the Queſtion; for in the direct Rule, that of the other two which agreeth with it in Name or Reſpect, is the firſt, which you may ſet to either of the other.

As, if the Queſtion be: If 32 Bricks pave one ſquare Yard, how many Bricks will pave 12 Yards? Here 12 is the third Number, and 1 the firſt, (both being of a Name) which ſet 12 or 32, againſt the other is 384 Bricks; but for the moſt Part the firſt Numbers are given, as you will find after.

5. It is not hard to know the Value of the fourth Number, for every Number on the Line increaſing or decreaſing in a tenfold Proportion, the Nature of the Queſtion or the Thing meaſured will diſcover it; as in the Example above, the fourth Number may be 384, or 38.4, or 3.84; but it is evident that it cannot be either of the two latter, much leſs 3840; ſo is it in any other.

## PROP. I.

### *Multiplication*, 1 *being the firſt Number.*

### Sect. 1. *The Square.*

Multiply the Side by itſelf; let the Side be 14 Foot, ſet 1 to 14 (beſt in the firſt Length) againſt 14 on the firſt is 196 Foot. This is alſo found on the ſquare Line.

## Sect. 2. *The long Square.*

*Qu.* 1. Multiply the longer Side by the ſhorter. A Wall is $30\frac{1}{2}$ Foot long, and 16 Foot high; ſet 1 to 16, againſt $30\frac{1}{2}$ is 488 Foot.

*Qu.* 2. A Length is 42 Foot, the Breadth $\frac{3}{4}$ Foot; ſet 1 to 42, againſt the Decimal .75 is $31\frac{1}{2}$ Foot.

*Qu.* 3. How many Men are in a Body, where they ſtand 18 in Front, and 8 deep? Set 1 to 8, againſt 18 is 144.

## Sect. 3. *The Triangle.*

Multiply the Baſe and Perpendicular, the one whole by half the other, which you will. In the Pike End of an Houſe, the over-way is 18 Foot, the Diſtance from the Pike to the over-way (being the Perpendicular) 16; ſet 1 to 8, againſt 18 (as before) is 144 Foot; or ſet 2 to either Perpendicular or Baſe, againſt the other is the Content.

## Sect. 4. *The Trapezium.*

It is an irregular four-ſided Figure. An irregular Plot (as of Land) before the Content can be found, is divided into theſe Trapezia and Triangles.

To find the Content, draw a Line from one Corner to his oppoſite one thro' the Trapezium, ſo as (if it may be) the two Perpendiculars falling from the other two Angles upon this diagonal Line (as they call it) may fall within the Trapezium; yet if one falls without, the Rule holds, but then the ſaid diagonal Line muſt be produced far enough.

So have you two Triangles having one common Baſe; multiply this Baſe by half the Sum of the Perpendiculars, the Product is the Content of the Trapezium; or ſet 2 to the Baſe, againſt the Sum of the Perpendiculars is the Content.

There is a Trapezium much uſed by the beſt Surveyors of Land, who, when they meaſure againſt a crooked Limit, be it Hedge, Ditch, or River) carry their Chain ſtrait from Mark to Mark, and taking Perpendiculars from the Chain to the Bents, Nooks, or Windings of the Limit, deſcribe Trapezia's in their Plot, have each two parallel Sides, and two right Angles.

The Content is found by multiplying half the Sum of the parallel Sides (being the Perpendiculars) by the neareſt Diſtance between them, being the intercepted Part of the ſaid Chain Line; the Product is the Content.

So is meaſured any Trapezium which hath two parallel Sides, tho' the Angles be not right; but then one Side muſt be continued, if need be, for this Line of neareſt Diſtance muſt be perpendicular to the parallel Sides.

Thus may the Rhombus and Rhomboid be meaſured, and infinite others, neither æquilateral nor æquiangular.

### Sect. 5. *Any regular Figure.*

Whoſe Sides being equal, the Angles are alſo equal; multiply half the Sum of the Sides by the Perpendicular let fall from the Center to one of the Sides.

*Example.* A Table hath 6 Sides, each Side 2 Foot, the Perpendicular 1.73 Foot; ſet 1 to 1.73, againſt 6 is 10.4 Foot.

## Sect. 6. *The Circle, and his Parts.*

1. The ſuperficial Content hereof is beſt found by *Prop.* 15. *Part* 3. It is alſo found by multiplying half the Circumference by the Semi-diameter.

2. For the Semi-circle, multiply half the Arch Line by the Semi-diameter.

3. The Sector, which is any Part contained between two Semi-diameters and the Arch Line, is alſo meaſured the ſame Way.

4. If a ſtrait Line be drawn thro' a Circle, not thro' the Center, it divides the Circle into two Segments; the Meaſure of the leſs is thus: Meaſure the Sector, whereof the Segment is a Part, then ſubtract the Content of the triangular Part, the Remainder is the Content of the Segment; but in the greater Segment the Content of the included Triangle muſt be added.

5. Having the Chord (*viz.* the ſtrait Line above-mentioned) of a Segment, and the Part of the Diameter intercepted between the Chord and the Arch, to find the whole Diameter.

As the intercepted Part of the Diameter to half the Chord, ſo the ſaid half Chord to the other Part of the Diameter; add them, and you have the whole.

6. The Diameter and Circumference are as 7 and 22; ſet 7 to 22, againſt any Diameter is his Circumference; ſet 22 to 7, againſt any Circumference is his Diameter; or having ſet 7 to 22, againſt the Circumference on the ſecond is the Diameter on the firſt.

## Sect. 7. *To reduce the aforeſaid Figures to Squares.*

Some of them, as the Triangle, long Square, &c. are reduced, as is ſhewn in the Meaſure of

Timber of ſuch Baſes; the other, as alſo any irregular Figure, thus: Firſt find the ſuperficial Content, then ſet the ſquare Line to his Squares, as is before taught, againſt the ſuperficial Content on the Line of Numbers is the Side of the Square.

## PROP. II.

### *Diviſion, wherein the Diviſor is the firſt Number.*

*Qu.* 1. IF 32 Bricks pave one ſquare Yard, how many Yards will 500 Bricks pave? Set 32 to 500, or to 1, againſt the other is 15.6 Yards.

*Qu.* 2. If 25 Trees coſt 21 *l.* what doth 1 Tree coſt? Set 25 to 21, being neareſt, againſt 1 is 0.84 *l.* whereof the 8 is 16 Shillings, and the 4 is 9*d.* ½, as you will after ſee.

*Qu.* 3. The Content of a Rectangle or long Square being divided by one Side, (whether the longer or ſhorter) the Quotient is the other. Suppoſe 144 Men placed 24 in Front, how many deep do they ſtand? Set 24 to 144, againſt 1 is 6.

## PROP. III.

### Sect. 1. *The Rule of Three direct.*

WHEN the Length is meaſured in Feet, the Breadth in Inches, and yet the Content required in Feet, 12 is the firſt Number, marked as 12 on the ~~ſquare~~ Lines chiefly for the Meaſure of Plank, or Board, and Glaſs.

*Qu.* 1. A Plank is 36 ½ Foot long, 18 Inches broad; ſet 12 to either Length or Breadth, hereto 18, being neareſt, againſt 36 ½ is 54 ¾ Foot.

of Numbers mark'd B. & C.

*Qu.* 2. A Board is 14 Foot long, 26 Inches broad; ſet 12 to 14, againſt 26 is 30 $\frac{1}{3}$ Foot.

*Qu.* 3. A Pane of Glaſs is 2 $\frac{1}{4}$ Foot long, 7.6 Inches broad; ſet 12 to 7.6, againſt 2 $\frac{1}{4}$ is 1.42 Foot, which .42 is almoſt an half.

## Sect. 2. *Sawyers Meaſure.*

They account 120 to the Hundred. If you would know the Content of a Stock of Plank or Board in ſuch Meaſure; having found the Content of one Plank or Board by the Section aforegoing, ſet 120 (repreſented by 12) to the ſaid Content, or to the Number of Karſes or Cuts, (which are always leſs by one than the Number of whole Boards in the Stock) againſt the other are the Sawyers Hundreds, which will fall in the ſecond Length, except there be not 100 Foot in the Stock. The Tenths are each of them 12 Foot.

*Example.* Admit there were 22 Boards in the Stock mentioned *Qu.* 2. of the foregoing Section, the Content of one Board is 30 $\frac{1}{3}$; ſet 12 to 21, the Number of Karſes, againſt 31 $\frac{1}{3}$ is 5.31 near.

Which is 5 hundred and 37 Foot; for every Tenth being, as is ſaid, 12 Foot, if you ſet 10 to 12, againſt 31 is 37 and more.

## Sect. 3. *Glaſs.*

It is moſt convenient in Glaſs to meaſure the Length as well as Breadth in Inches; yet the Content being required in Feet, 144 (repreſented by 14.4 is your firſt Number, and the Content, if a whole Foot, or above, in the ſecond Length, as next before.

*Example.* A Pane of Glaſs is 31 $\frac{1}{2}$ Inches long, 8 $\frac{1}{2}$ broad, ſet 144 to 8 $\frac{1}{2}$, againſt 31 $\frac{1}{2}$ is 1.86 Foot.

Let there be 7 ſuch Panes, ſet 1 to 1.86, againſt 7 is 13 Foot.

### Sect. 4. *By the Yard.*

In the following Queſtions both Length and Breadth are to be meaſured in Foot Meaſure. If the Content be required in Yards, 9 is the firſt Number, there being 9 ſquare Feet in a ſquare Yard. So they meaſure Painting, Paving, Plaiſtering, Wainſcot, *&c.*

*Example.* A Length is 24 Foot, the Breadth 10 ½; ſet 9 to 10 ½, againſt 24 is 28 Yards.

### Sect. 5. *By the Square of* 10 *Foot, as in Tiling, Flooring,* &c.

Here 100 is the firſt Number. A Roof is 41 Foot long, and the Spar 20 ½ Foot; ſet 100 to 41, againſt 20 ½ is 8.4 Squares.

### Sect. 6. *By the ſquare Rod, at* 16 ½ *Foot to the Rod, as in Brick Walls.*

Here 272 ¼ (being the Square of 16 ½) is the firſt Number; alſo 272 being cut on theſe Rules, may ſerve without conſiderable Error. A Wall is 110 Foot long, 9 ½ Foot high; ſet 272 to 110, againſt 9 ½ is 3.83 Rod in the ſecond Length. If you would have a Mark at 324, the Square of 18, ſet 18 to 10, againſt 18 on the ſecond Mark the Point.

### Sect. 7. *By the Acre.*

In Land Meaſure 160 ſquare Perches, Poles, or Rod (commonly at 16 ½ Foot, in ſome Places 18 Foot to the Pole) make an Acre, therefore 160 (repreſented by 16) is the firſt Number; the Parts are 40 Pole to the Rood or Quarter, 80 to 2 Roods, 120 to three; the Lengths and Breadths are meaſured in Poles.

*Example* 1. A Length is 35 Perches, the Breadth 19; ſet 160 to 19, againſt 35 is 4.15 Acres.

*Example* 2. A triangular Piece of Land hath the Baſe 24 Poles, the Perpendicular 16 $\frac{1}{2}$; ſet 160 to 16 $\frac{1}{2}$, againſt 12 (half the Baſe) is 1.24 Acre near; or ſet 320 to the Baſe 24, againſt the Perpendicular 16 $\frac{1}{2}$ is 1.24, as before.

## PROP. IV.

### *The inverſe Rule.*

HERE the Number that goeth with the Queſtion is the firſt Number, which you may ſet to either of the other.

*Example.* It ſeems 272 $\frac{1}{4}$ Foot make a Rod of Brick Wall at only 1 $\frac{1}{2}$ Brick Thickneſs; if it be thicker, fewer Feet anſwer a Rod; if thinner, then more, at an inverſe Proportion.

If it be demanded how many Feet anſwer a Rod (for Example) at two Bricks Thickneſs,

Set 2 (which goeth with the Queſtion) to 1 $\frac{1}{2}$, againſt 272 $\frac{1}{4}$ is about 204, *viz.* 204.18 Foot; and ſo for any other Thickneſs, which may be marked for firſt Numbers thus: ſet 1 $\frac{1}{2}$ to any Thickneſs, againſt 272 $\frac{1}{4}$ on the ſecond mark the Points.

## PROP. V.

### *Fractions.*

BY Fractions I mean Decimals; a general Rule for them is: Set 10 or 100 to the Number of Parts (that make the whole) in the Queſtion, againſt every Decimal is its own Share or Portion of the ſaid Parts.

## Sect. 1. *Of a Pound Sterling.*

The firſt Figure after the Prick in any Decimal of a Pound, is ſo many two Shillings, double it therefore, and you have the Shillings anſwering; 5 in the next Place is one Shilling; theſe being accounted, ſet 100 to 24, againſt the remaining Decimal are the Pence; if there be not 5 in the ſecond Place, having ſet as above, againſt the other is the Pence, the Farthings being very eaſily eſtimated on the Rule.

*Example.* Let 688 be the Decimal, the 6 is 12 *s.* and 5 in the next 8 is 1 *s.* ſet 100 to 24, againſt 38, the remaining Decimal, is 9 *d.* in all 13 *s.* 9 *d.*

Or without the Rule thus: Having taken out the Shillings, as above, if the remaining Decimal exceed not 30, account them Farthings, abating one; if it exceed 30, take 25 out of it, which is 6 *d.* and the Remainder account Farthings, abating one.

*Note*, That the Decimal is ſuppoſed of three Places at leaſt; if it be but of two, ſuppoſe a Cypher for the third; and if there be more, you may neglect them, with the Caution in the like Caſe before given.

So taking .25 out of .38, (in the Example above) the remaining 13 account 12 Farthings, or 3 *d.* ſo the whole is 9 *d.*

## Sect. 2. *Of a Rod.*

At 30 *s.* the Rod, what are 28 Cents? Set 100 to 30, againſt 28 is 8.4, *viz.* 8 *s.* and 4 Tenths; ſet 10 to 12, againſt 4 is 4 *d.* ¾; in all 8 *s.* 4 *d.* ¾.

## Sect. 3. *Of an Acre.*

How many Perches are 15 Cents of an Acre? Set 100 to 160, againſt 15 are 24 Perches. More Examples are needleſs.

## Sect. 4. *Vulgar Fractions into known Parts.*

Set the Denominator, being the lower, to his Numerator, againſt the Number of known Parts in the whole is the Number of Parts required; or ſet the Denominator to the Number of Parts, againſt any Numerator is his Portion of the ſaid Parts.

How many Farthings are $\frac{5}{7}$ of a Shilling? Set 7 to 48, againſt 5 is 34, or 8 *d.* 2 Farthings.

## Sect. 5. *Vulgar Fractions into Decimals.*

Set the Denominator to his Numerator, againſt 100 is the Decimal required. What Decimal of a Foot is $\frac{7}{12}$ or 7 Inches? Set 12 to 7, againſt 100 is .58 near enough, or .583.

The aforegoing Examples being well underſtood, it will not be difficult to apply the double Scale to any other Subject.

# THE ART OF Practical Meaſuring, &c.

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## PART V.

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### SECTION I.

*The diagonal Scale.* (Fig. III.)

IT conſiſteth of 21 equidiſtant parallel Lines thorough the Length of the Scale, and of tranſverſe Parallels at a Quarter of an Inch Diſtance one from the other, with 5 Diagonals thorough the uppermoſt Integer. In the Parallel of 10 there is a Cypher at every Tranſverſe. This Row of Cyphers divides the whole Scale into two Scales, having one diagonal Integer over both.

It is fitted chiefly to *Gunter*'s Chain, which is accounted the beſt for ſurveying of Land, and is of 16 Perches in the Inch.

If the Place of Tens in the Links be 0, 2, 4, 6, or 8, (the laſt four whereof are ſet againſt their reſpective Diagonals) uſe the firſt or left Hand Scale; but if the Place of Tens be 1, 3, 5, 7, or 9, uſe the ſecond or right Hand Scale; for that Diagonal which is 20 (for Example) in the firſt, is 30 in the ſecond; that which is 40 in the firſt, is 50 in the ſecond, *&c.*

*Example* 1. Let 10 Chains and 46 Links be required from the Scale, ſet one Foot of the Compaſſes on the long Parallel or Link Line, repreſenting 6 in the 10th Chain Line or Tranſverſe, and firſt Scale, and extend the other to the Diagonal 40 in the ſaid Link Line of 6.

2. But to take off 10 Chains and 56 Links, ſet one Foot on the Link Line of 6 in the ſaid tenth Chain Line, and ſecond Scale, and extend the other to the ſame Diagonal in the ſaid Link Line of 6, ſo have you the Lines required.

3. So having a Line on your Plot, to know how many Chains and Links it is, take it with your Compaſſes, and carry it parallel to the Link Lines, one Foot in one of the Chain Lines, and the other thorough the diagonal Integer, till it falls on one of the Diagonals, and according as it falls in the firſt or ſecond Scale, ſo account the Tens of your Links.

The Scale may be made to 20 in the Inch, (as it is commonly to 12, and ſet on the other Side) which muſt needs exceed any plain Scale of that Dimenſion for Exactneſs.

## SECT. II.

### *Gunter's Chain.*

IT is 4 Perches long, at 16 ½ Foot to the Perch, theſe make 792 Inches; it hath 100 Links, ſo each Link is 7.92 Inches.

Theſe Chains are diſtinguiſhed with Pieces of Braſs at every tenth Link, which Pieces contain ſo many Corners or Points as they are Tens of Links diſtant from either End of the Chain, thus: That Braſs at 10 Links has one Tippet or Point, that at 20 has two, that at 30, three; that at 40, four; and the ſame again from the other End; but at 50, the Middle, is a large round Piece of Braſs; and at 25, from each End, two Curtain Rings together. By the Help of theſe Diſtinctions (which are plainer, and far more viſible than the old Way of Rings alone) you will ſpeedily find the Number of Links.

Altho' the Chain be divided into 4 Perches by the two double Rings and the large Braſs Circle in the Middle, ſo that it may be applied to the Meaſure of any Length by the Pole, yet in meaſuring Lengths in ſurveying we take Notice only of Chains and Links, not concerning ourſelves with Perches till we caſt up the Content.

To multiply a Length and Breadth meaſured with this Chain, reduce them into Links, which is no more Trouble than to ſet the Links at the right Hand of the Chains; or if there be no Links, to put two Cyphers there; ſo 4 Chains and 32 Links are 432 Links, and 7 Chains are 700 Links, 10 Chains and 6 Links are 1006 Links.

Having multiplied a Length by a Breadth, the ſixth Figure of the Product to the left Hand (if there be ſo many) is Acres compleat, the ſeventh Tens of Acres.

*Example* 1. If you multiply 5 Chains and 82 Links by 3 Chains and 21 Links, the Product is 1.86822, whereof the 1 is one Acre.

```
Ex. 1.     582
           321
      ---------
           582
         1164
       1.746
      ---------
       1.86822
```

Alſo 13 Chains and 42 Links by 8 Chains and 70 Links, the Product is 11.67540, whereof the 11 is eleven Acres. The Decimals are reduced to Roods and Perches as followeth.

```
Ex. 2.   13.42
           870
      ---------
         93940
       10736
      ---------
       11.67540
```

## SECT. III.

### *To reduce the Decimal Lines of* Gunter's *Chain into Poles.*

AN Acre is 160 ſquare Perches, as hath been ſaid, equal to 100,000 ſquare Links of this Chain, which being divided by 160, the Quotient 625 is the ſquare Links of one Perch or Pole; this, as it is the Decimal of an Acre, ought to be expreſſed thus .00625, as alſo all other, *viz.* with 5 Places, except it be even Tens, for a Cypher or Cyphers at the left Hand are of no Value, as hath been ſaid.

The Parts of an Acre are firſt 4 Roods, whereof 4 is your firſt Multiplier, and there being 40 Pole in a Rood, 40 is your ſecond.

Or if you multiply your Decimal by 160, the Figures remaining to the left Hand, after the Decimal be cut off, are Perches immediately.

But where the Content is not exacted to half a Pole, we uſually take this ſhorter Courſe, without prefixing Cyphers.

It is evident, that if the Places of the Decimal be but three, there cannot be two Poles; if they be four, multiply the firſt Figure by 6; if five, multiply the two firſt Places by 6, in both ſet the Product one Place back toward the right Hand, then add together the firſt, or two firſt Places (reſpectively) of the Decimal and Product ſo ſet, adding alſo a Unit for every 6 that ſhall be in the Figures of the next Place, the Sum is the Number of Poles in the Decimal.

See here two Examples, one of 4 Places, the other of five; alſo you ſee how the Products are placed and added.

*Ex.* 1. *Links* 8172
48
*Poles* 13

In the firſt there is once 6, in the ſecond twice 6, in the Figures of the next Place, for which 1 in the firſt, and 2 in the ſecond, are added to the other; the two Places to the right Hand are neglected, as never amounting to the ſixth Part of a Pole.

*Ex.* 2. *Links* 21726
126
*Poles* 35

The Reaſon of this Operation, Mr. *Wingate* (in whoſe Arithmetick I firſt met with it, uſed alſo by Mr. *Atwell*, as you may ſee in his Book of ſurveying printed *Anno* 1662, which I value beyond moſt Books of that Subject printed ſince) deeming it not very obvious, leaves to the Search of the Curious. Take it here:

1. If 100 (which are ſo many thouſand ſquare Links being an Acre) require 60 to be added to it to make it 160 Poles, being alſo an Acre, what ſhall any other Number of thouſands of ſquare

Links require to be added to it to turn it into Poles ?

2. To multiply a Number by 6, and divide the Product by 10, gives the ſame Quotient which you have by multiplying the ſame Number by 60, and dividing the Product by 100.

3. Setting the Product a Place back to the right Hand, both divides by 10, and ſeats it for Addition.

## SECT. IV.

### *A ready and exact Way by the Rule.*

ON the double Scale ſet 100 to 16, againſt the Links are the Poles anſwering ; neglect the two laſt Figures, as is ſaid.

If the Decimal be 60,000, or more, take 5 out of the firſt Figure, accounting for it 2 Roods, and find the Poles anſwering the Remainder ; let the Decimal be .82511, deducting 5, the Remainder is .32511 ; ſet 100 to 16, againſt .325 is 52, *viz.* 1 Rood and 12 Pole ; ſo the Decimal is 3 Rood 12 Pole.

## SECT. V.

### *Having the three Sides of a right Line Triangle, to find the ſuperficial Content.*

ADD the three Sides together, from half the Sum ſubtract each Side ſeverally, ſo you have three Remainders, multiply theſe three and the half Sum continually, that is, the firſt Remainder by the ſecond, the Product by the third, and this Product by the half Sum, the ſquare Root of this laſt Product is the ſuperficial Content.

Moſt eaſily and ſpeedily by the Logs. thus: Add the Logs. of the three Remainders and the half Sum together, half the Sum is the Log. of the ſuperficial Content.

*Example.* Let the Sides be 1050, 854, 774, the half Sum is 1339, the three Remains 289, 485, 565, the Content is 3 Acres, 1 Rood, and 1 Perch near: This is the moſt certain Way of meaſuring Land, where the Triangles can be meaſured in the Field; which otherwiſe are firſt plotted on Paper, and the Length of the Baſe and Perpendicular of every Triangle meaſured upon the plotting Scale, and from them the Content caſt up, as has been ſhewn before: Not but there are Methods by which you may caſt up the Content of Lands, tho' ever ſo irregular, without plotting, and that to the greateſt Truth imaginable, as being grounded upon a Theory, as true as any Propoſition in *Euclid*, and where the utmoſt Exactneſs poſſible is required, is doubtleſs the beſt Way.

| | |
|---|---|
| 1339 | 3.12678 |
| 289 | 2.46090 |
| 485 | 2.68574 |
| 565 | 2.75205 |
| *a.* | 11.02547 |
| 3.25640 | 5.51273 |
| 150 | *a. r. p.* |
| 41 | 3. 1. 01 *near* |

# *Here follows the Deſcription of the other Side of the Rule, which is applied to find the Lengths and Angles of Hips, Rafters, and Collar-Beams, whether the Roof be ſquare or bevelling, and that at any Pitch.*

FIRST then, on the innermoſt Edge of each Leg or Joint of the Rule, is drawn a Line from the Center, numbered 2, 3, 4, 5, 6, and ſo on to 15, whoſe Uſe is to divide a Circle into any Number of equal Parts not exceeding 15.

Next to theſe Lines on each Joint is drawn another Line, which is divided into 30 equal Parts repreſenting ſo many Feet, each Foot being divided into 12 equal Parts to expreſs the Inches.

There is on one of the Legs a Line divided into 40 equal Parts, of the ſame Length with the 30 Scale, which alſo repreſents Feet, each Foot being divided into 6 equal Parts, and therefore each Diviſion is 2 Inches.

On the other Leg, next the 30 Scale, is a Line of Chords, numbered 10, 20, 30, and ſo on to 180, each of which Parts are divided into 10 more, to expreſs each ſingle Degree, whoſe Uſe is to find the Quantity of any Angle in Degrees and Minutes.

Before we proceed to the Uſe of theſe Lines, it won't be improper to explain what is meant by the Terms Lateral and Parallel.

Firſt, By the Word Lateral is meant any Diſtance taken in a ſtrait Line from the Center, either upon the 30 or 40 Scale, or upon the Line of Chords.

For Inſtance, ſuppoſe I would take 20 Feet laterally off of the 30 Scale, fix one Point of the Compaſſes in the Center, and extend the other to 20 on the 30 Scale of either Leg, and the ſaid Extent is called a lateral Extent of 20 Feet. And ſo for any other.

2. By a parallel Extent, we mean any Diſtance taken by extending the Compaſſes from any Number of Feet and Inches on the 30 Scale of either Leg, to the like or unlike Number on the 30 Scale of the other Leg, as thus: The Rule being any how opened, the Compaſſes extended from 25 on one Leg to 25 on the other, is a parallel Extent of 25 Feet; but if it had been extended from 25 on one Leg, to any other Number more or leſs on the other Leg, it's ſtill called a parallel Extent.

3. When one Point of the Compaſſes is fixed in a given Point, and the other ſo opened or ſhut as juſt to touch a given Line, that Extent is called the neareſt Diſtance between the ſaid Point and Line.

### 4. *How to repreſent any Number of Feet and Inches by a right Line.*

Extend the Compaſſes laterally from the Center on the 30 or 40 Scale to the Number propoſed, and that is the Length of the Line required.

5. But if theſe Scales are too great or ſmall; for Inſtance, ſuppoſe you wanted a Line of 4 Inches to be divided into 30 equal Parts, or, which is the ſame Thing, to have a Line of 4 Inches repreſent 30 Feet; proceed thus:

Take 4 Inches between your Compaſſes from off the Scale of Inches, and make the ſaid Extent a Parallel in 30 and 30, and thus the 30 Scale is ſet to your Deſire.

### 6. *To ſet the* 30 *Scales ſquare.*

Take 90 from off the Line of Chords with your Compaſſes, and make the ſaid Extent a Parallel in 15 and 15 of the 30 Scales, and then the ſaid Scales are ſet ſquare or perpendicular to each other.

After which ſhort Deſcription and Uſe of *Scamozzi*'s Lines, let us apply them to that Part of Building, where the Length of Hips, Rafters, and Angles are concerned, whether the Frames be ſquare or bevelling, *&c.*

## PROP. I.

LET ABCD, in *Fig.* I. repreſent the Frame of a Houſe bevelling at one End and ſquare at the other, the Gable End being ſquare, and the Bevel hipt.

In which A B is 11 Feet, B C 14 Feet 5 Inches, CD 9 Feet 6 Inches, and AD 20 Feet, and having drawn the Poſition of the Frame according to theſe Lengths, draw the Gable End DEC, whoſe Rafters DE and CE are each equal to three Fourths of the Breadth of the Houſe CD; biſect or divide the Lines AB and CD into two equal Parts in the Points G and F, and draw the Line

FG

F G for the Ridge of the Houſe; and E F, the common Perpendicular, will repreſent the Height thereof above the Floor.

Next, make G H equal to B G or G A, and thro' the Point H draw the Diagonal A I and B I, which will ever interſect each other at right Angles; and then thro' H draw the Lines P S and *m n*, the former perpendicular to F G, and the latter parallel to A B.

### *To find the Length of the Hips.*

Make H I equal to E F (5 Feet 4 Inches) the Height of the Rafters perpendicular, and draw the Lines A I and B I for the two Hips, A I in this Caſe being the longeſt, and B I the ſhorteſt, which being raiſed to their proper Pitch, will meet the principal Rafters K P and L S perpendicular to the Point H.

### *To find the Back of the Hips, ſo that it may anſwer both Sides and Ends of the Roof.*

Lay the Ruler from G to *n* and from G to *m*, and interſect the Diagonals H B and H A in the Points *u* and *w*; then with one Point of the Compaſſes fixed in the Point *u*, with the other take the neareſt Diſtance to the Hip B I, and lay it off from *u* to M, and drawing the Lines *n* M, M G, they will form the Angle *n* M G, equal 137°, for the Back of the leſſer Hip B I.

Alſo, if with one Point of the Compaſſes fixed in the Point *w*, you take the neareſt Diſtance to the Hip A I, and lay it off from *w* to M, and draw the Lines *m* M, M G, you will have the Angle *m* M G, equal 99°, for the Back of the longeſt Hip A I.

And if you make K P, D Q, L S, and C R, each equal to the Rafters C E or D E, and join the Points Q P and S R, they will be the Length of the Ridge of the Roof, each being equal to F H. Now, if to P K or D Q, and to L S or C R, you draw Lines parallel, about 12 or 14 Inches diſtant from each other, at which Diſtance it ſeems Rafters ſtand, and allowing for their Breadth, you will have them repreſented to your View as they lie in Ledgment; alſo if A N and B N (equal to the Hip Rafters A P and B S) are drawn, they will appear juſt in the ſame Manner as when they lie in Ledgment.

## *With the Rule to find the Length of the Rafters by Inſpection, when true Pitch.*

Againſt 9 Feet 6 Inches (the Breadth of the Houſe) upon the 40 Scale is 7 Feet 1 ½ Inches upon the 30 Scale, for the Length of the Rafter; alſo againſt 7 Feet 1 ½ Inches upon the 40 Scale, is 5 Feet 4 Inches upon the 30 Scale, for the Length of the Rafter's Perpendicular, or Height of the Ridge above the Floor.

But if the perpendicular Height of the Gable End ſhould be agreed on, and by that means the Roof be above or under true Pitch, then open the Rule, ſo that the 30 Scales may ſtand perpendicular to each other, and count half the Breadth of the Houſe upon one Leg from the Center, and the Height of the Perpendicular upon the other, *viz.* both upon the 30 Scales, and the parallel Diſtance between them meaſured laterally upon the 30 Scale, will give the Length of the Rafters.

## *EXAMPLE.*

Suppoſe the Breadth of a Houſe be 35 Feet, and the perpendicular Height of the Gable End 23, then working as above directed, and you will find the Length of the Rafter to be 28 Feet 10 Inches.

It's doubtleſs of great Uſe to know what Angles the Rafters make at Foot and Head, with the raiſing Piece and the King's Poſt, and of the Angles made at the Foot and Top of the Hips, and therefore I ſhall give one general Rule to meaſure any Angle.

Always take the Length of thoſe Lines which contain the Angle you would meaſure, and count them from the Center on the 30 Scales, and ſo open or ſhut the Rule, that the parallel Diſtance between them, may be equal to the Side oppoſite to the required Angle, taken laterally off from the 30 Scale by a Pair of Compaſſes; and then if the parallel Diſtance between 15 and 15 be meaſured upon the Line of Chords, it will ſhew the Degrees and Minutes of the Angle.

## *EXAMPLE.*

Suppoſe it was required to meaſure the Angle D E F, *viz.* the Angle made by the Rafter D E, and its perpendicular Height E F.

Firſt, I take the lateral Extent of 4 Feet 9 Inches in my Compaſſes off of the 30 Scale, which is the Side oppoſite to the Angle ſought, then apply it parallel, by fixing one Point of the Compaſſes in 5 Feet and four Inches on the 30 Scale of either Leg, and ſo open or ſhut the Rule, that the other Point of the Compaſs may reſt upon 7 Feet 1 ½ Inches on the 30 Scale of the other Leg; and then taking the Diſtance with your Compaſſes between 15 and 15, and meaſuring it laterally upon the Line of Chords, the Quantity of th Angle ſought will appear to be 41 Degrees 5 Minutes, which ſubtracted from 90 Degrees, an ther

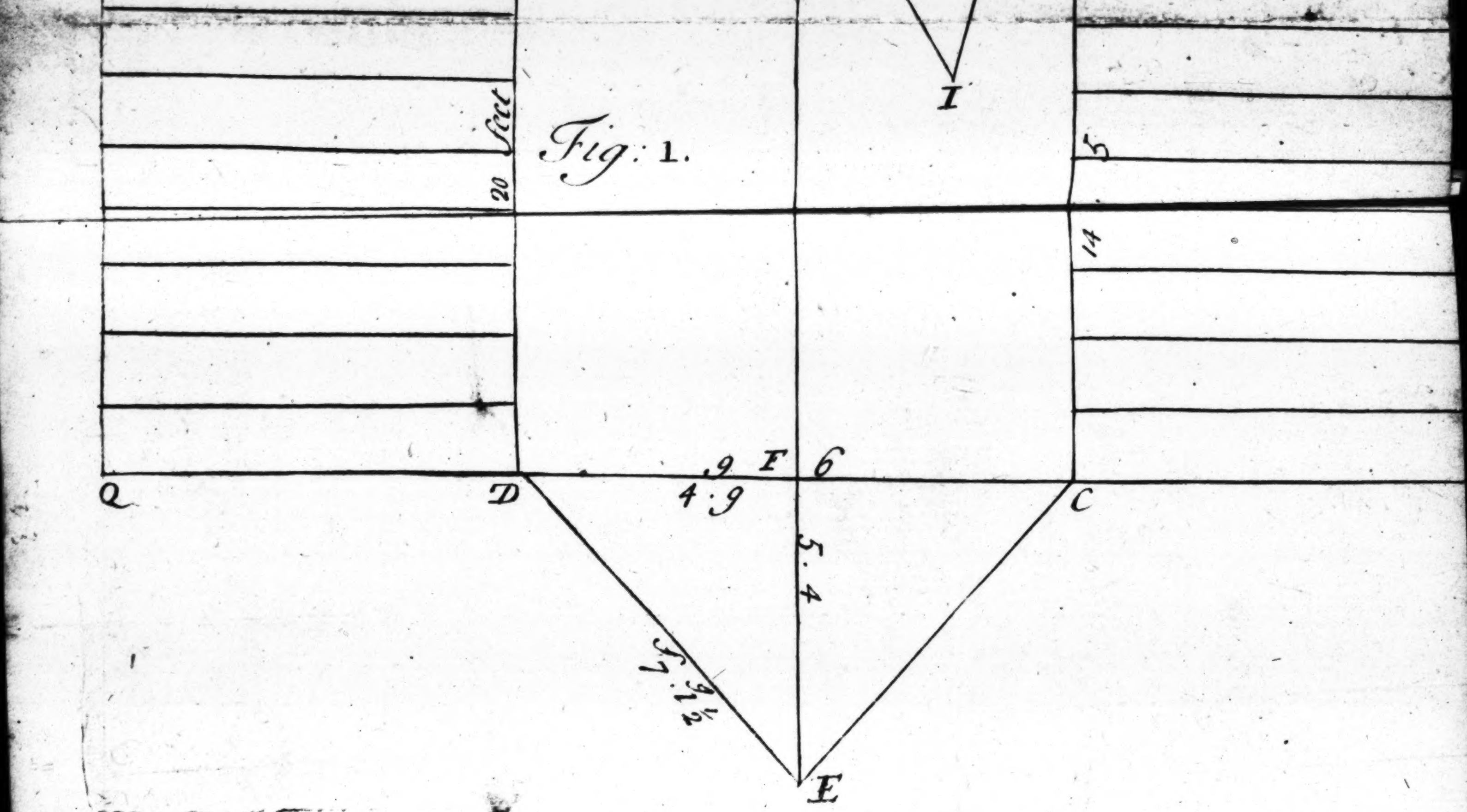

Fig: 1.

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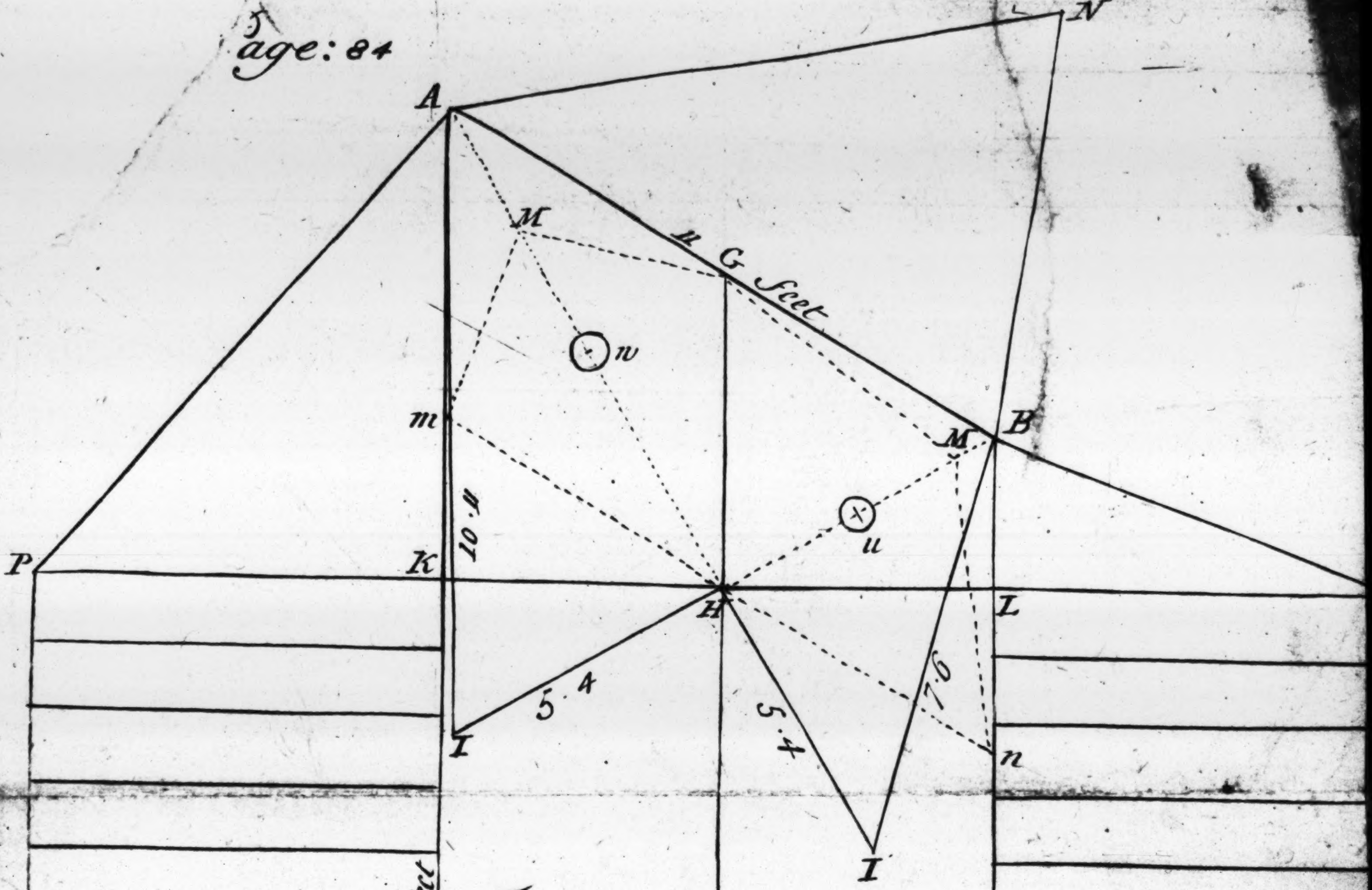

here will remain 48 Degrees 10 Minutes for the Angle FDE at the Foot of the Rafter.

Or the Angle DEF may be meaſured thus : Lay the innermoſt Edge of either Leg juſt to ouch the Line EF, the angular Point E being as near to the Center of the Rule as poſſible for the Braſs Joint ; then ſo open or ſhut the other Leg of the Rule, that it may remain parallel to the Line DE, and the parallel Diſtance between the two little Lines drawn upon the inner Edges of the Rule at 15 and 15, meaſured upon the Line of Chords, will give the Degrees and Minutes of the Angle, equal 41 Degrees 5 Minutes, as before.

And after this Manner the Angle at the Back of the Hips may be taken with a Bevel, and ſerve in Practice, as well as if taken by the Rule, and the Degrees and Minutes of the Angle determined.

## PROP. II.

### *To find the Rafters, Hips, and Angles of bevel and taper Frames.*

IN theſe Sort of Frames obſerve, that the Middle Breadth is the Guide for the Rafters Length, and that the Perpendicular at both Ends muſt be equal to the middle Rafters Perpendicular, to prevent the Roof's being higher in one Place than another ; for tho' a Pair of Rafters at one End of the Houſe will exceed the Length of a Pair at the other, yet, becauſe they and the reſt of the Rafters are proportioned by a common Perpendicular, all Parts of the Roof will be of an equal Height.

In *Fig.* II. Let ABCD repreſent ſuch a Frame, in which, beſides knowing the Lengths of the 4 Sides, it's neceſſary that one of the Angles ſhould be given, in order to lay down the Frame in its true Poſition ; for if one of the Angles be not determined, there may with the ſame 4 right Lines be conſtituted an infinite Number of Figures, and al different in Area and Form from one another ; Wherefore let the Angle D A B be 70 Degrees.

And then to deſcribe the Frame; having draw the Line A D equal to 26 Feet, proceed to la down the Angle D A B and the Side A B, afte this Manner ; take 70 Degrees, the Quantity o the Angle D A B, laterally off with your Compaſſes from the Line of Chords, and make th ſaid Diſtance a Parallel between 15 and 15 ; an then fixing one Point of the Compaſſes in 26, (o the 30 Scale of either Leg) which is the Lengt of the Side A D, extend the other to 11 Feet Inches on the 30 Scale of the other Leg, and wit this Extent, one Foot of the Compaſſes being fixe in the Point D, with the other deſcribe the ſmal Arch *r* B *s* ; and then taking 11 Feet 9 Inches between your Compaſſes, and fixing one Point in A with the other deſcribe the Arch *u* B *w*, an where the Arches interſect each other as in B draw the Line A B, and ſo ſhall the Line A B b laid down according to its true Length and Poſition : And ſince the Points D and B are know 'twill be eaſy to determine the Point C by th Length of the Lines D C and B C, which a alſo given, D C being 9 Feet 6 Inches, and B 18 Feet 10 Inches.

Next, divide D C into two equal Parts in th Point Z, and A B in the Point G, and havin drawn the Line Z G, which repreſents the Pla over which the Ridge of the Houſe muſt ſtan make G I equal to B G or A G, and Z F equal D Z or Z C, and thro' the Point I draw the Di gonals A *m* and B *k*, which will always interſe each other at right Angles, tho' the Frame be

an

and taper ever ſo much, as may eaſily be proved from the Elements of *Euclid*: Alſo thro' the Point F draw the Diagonals D*n* and C*b*.

Croſs Z G in the Middle at right Angles, as *yx*, which middle Breadth being upon Trial found to meaſure 10 Feet, three Fourths thereof, *viz.* 7 Feet and half will be the Length of the Rafter *bc*: And again, three fourths of the Rafter will produce 5 Feet 7 ½ Inches for the Rafters Perpendicular, or Height of the Ridge all over the Frame. This may be done by Inſpection by the 30 and 40 Scales on the Rule.

Which being either Way determined, let us proceed to find the Length of the Hips.

Firſt then, becauſe A I and B I repreſent the Diſtance of the King's Poſt, or Point over which the Hips will ſtand, when raiſed to their proper Places from the two Corners of the Frame A and B, and that the I H's are perpendicular to the ſaid Diſtances A I and B I, and both equal to 5 Feet 7 ½ Inches, the perpendicular Height common to all the Rafters.

I ſay, If you draw the Lines A H and B H, it's evident they will repreſent the two Hips at that End of the Houſe expreſſed by the Letters A G B, the greater Hip A H being 11 Feet and 1 Inch, and the leſs B H 9 Feet 6 Inches.

Moreover, if F K be made equal to *y o* 5 Feet 7 ½ Inches, and D K and C K drawn, they will, by being meaſured upon the 30 Scale, ſhew the Length of the Hips at the other End of the Houſe, *viz.* D K the greater Hip 9 Feet 6 Inches, and C K the leſs 7 Feet 9 Inches.

## *To find the Angles for the Back of the Hips.*

In order to which, fix one Point of the Compaſſes in I, the Foot of the King's Poſt, and with the other take the neareſt Diſtance to the Hips A H and B H, laying off the former Diſtance from I to M, and the latter from I to N, and drawing the Lines *k* M, M B and A N, N *m*, the Angle *k* M B will be 108 Degrees for the Back of the longeſt Hip A H, and the Angle A N *m* 124 Degrees for the Back of the leſſer Hip B H.

The Quantity of theſe Angles is found by the general Rule; as delivered before for meaſuring of all right Line Angles.

To repreſent the Breadth and Length of each Side of the Roof, raiſe two Perpendicular, *viz.* *a* Q and *d* P from the raiſing Piece A D, and ſo that, if continued both ways, they may paſs thro' the Points I and F; and then lay the Length of the Hip A H from A to P, and of D K from D to Q, and draw the Lines D Q, Q P, and P A, for one Side of the Roof.

Then make *q* T and *p* S perpendicular to the raiſing Piece B C, and ſo that they may likewiſe paſs thro' the Points I and F; then lay the Length of the Hip B H from B to T, and of C K from C to S, and join the Points C, S, T, and B, by drawing the Lines C S, S T, T B, which will form the Shape of the other Side of the Roof; and a Q P and S T are each equal to F I, the Diſtanc between the King's Poſts, ſo when they are turne over to meet in their proper Places, will repreſen the Ridge of the Houſe; and if A B V, the greate Hip, and D C E, the leſs, be turned over to thei reſpective Places, the Point V will meet the Point P and T, and be perpendicular to the Point I

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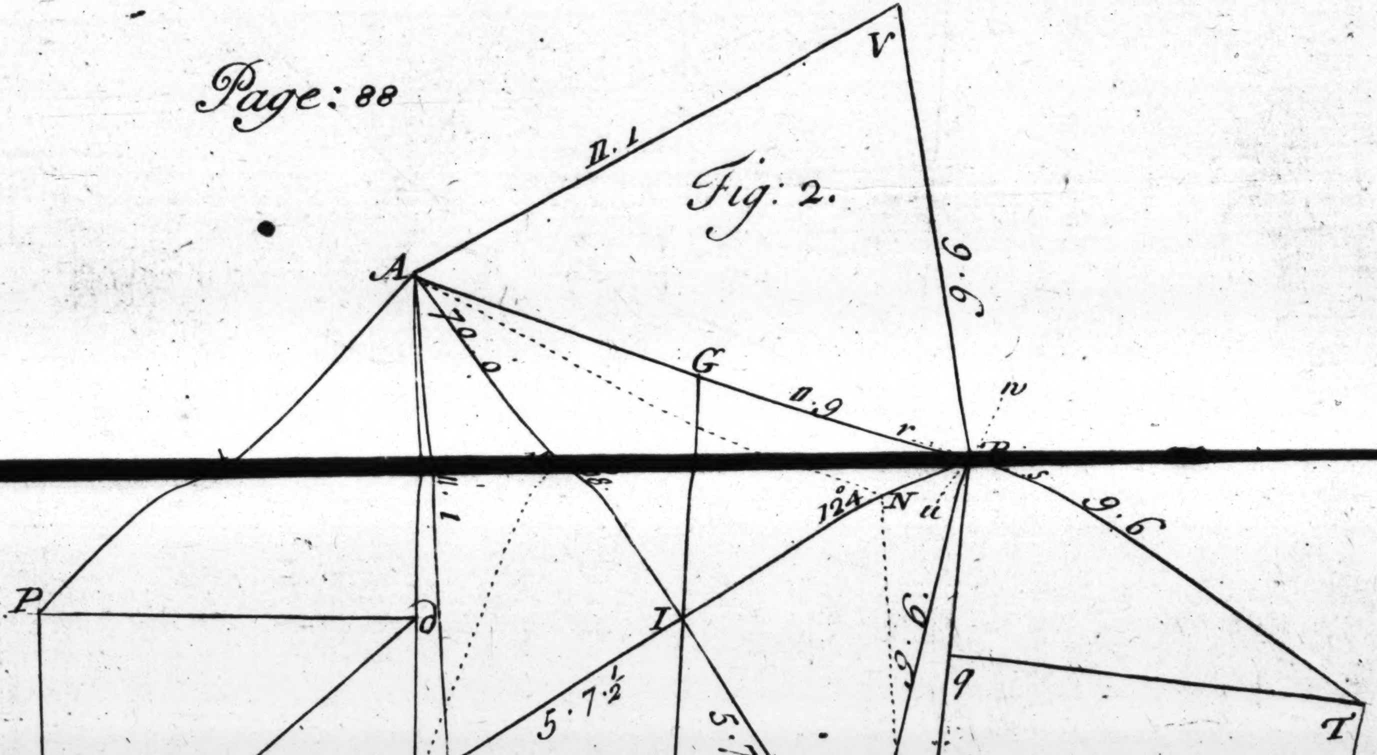
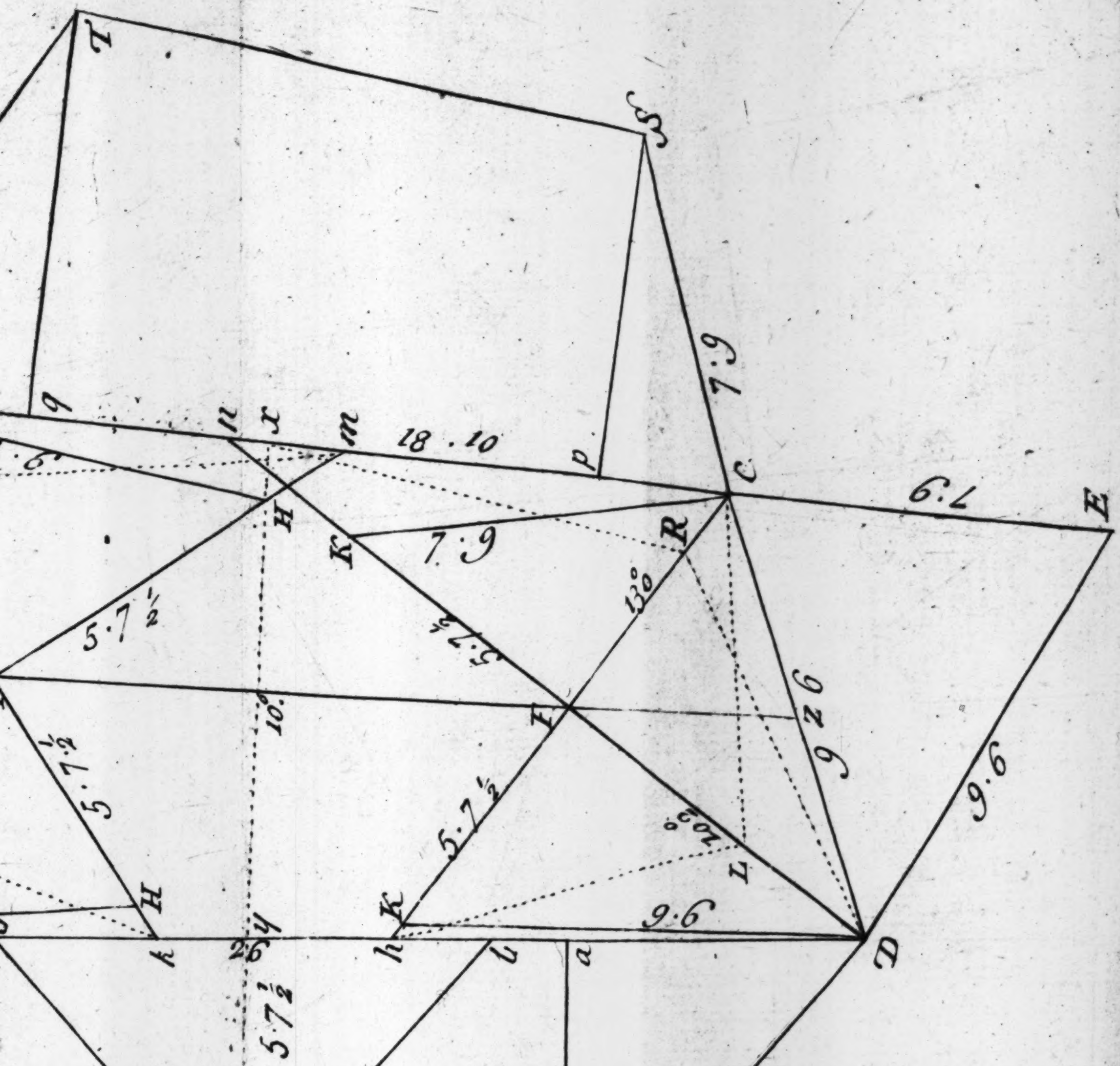
Fig: 2.

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and the Point E will meet the Points Q and S, and be perpendicular or right over the Point F.

### *To find the Lengths and Angles of Collar-Beams in any Roof.*

After having taken the whole Breadth of the Frame between your Compaſſes, ſet one Point thereof in the Length of the Rafter on the 30 Scale of either Leg, and let the other Point reſt in the Length of the Rafter, counted upon the 30 Scale of other Leg, which two Legs repreſent the two principal Rafters; and a Rule being laid from one Point of the Compaſſes to the other, repreſents the raiſing Piece; then at any Height you deſign the Collar Beam ſhall be above the raiſing Piece, if you apply a Ruler parallel to it, the Diſtance between the Rafters is the Length of the Collar-Beam, (allowing ſpare Wood for the Tenons) which Diſtance you muſt meaſure laterally from the Center on the 30 Scale; and as for the Angles to cut the Tenons by, they are the ſame as the Rafters make at Foot with the raiſing Piece.

## PROP. III.

### *To find the Lengths and Angles of Rafters and Purloins in Bevel Frames.*

IN *Fig.* III. let ABCD be a Frame bevelling at one End, and ſquare at the other: Firſt, The Length of the Lines or Sides of the Frame being determined, it will be eaſy (by what has been already ſaid) to lay it down in its true Poſition; which being done, draw A E parallel to B C, and produce CD to E; biſect or divide BC and AE into two equal Parts at the Points N and P, and draw N P for the middle Line of the Frame, and draw KH in the Middle between AB and NP, and MG in the Middle between NP and CE; and ſo will CK and BM repreſent the Length of a ſquare Pair of Rafters, each being three Fourths of the Breadth of the Frame BC, therefore equal to 15 Feet; three Fourths of which is 11 Feet 3 Inches, the Length of the Perpendicular common to all the Rafters.

Next, make FG and IH each equal to EP, and draw the Lines DI and AF, which will repreſent the Outſide Lines of the bevel End Rafters, and the Lines parallel to them the Inſide, as being drawn according to the Breadth or Scantling of the Rafters, which here is 8 Inches.

Thus the Lines AF and DI repreſent the bevel End Rafters, laid in Legment to fit in the Purloins, they lying out of Square according to the Angles GAF and CDI, the one being 11° 20′ leſs than 90°, and the other 11° 20′ more than 90°; which Angles alſo repreſent the Back of the Rafters at the Foot.

And as CK and BM repreſents a Pair of ſquare Rafters at ſome intended Diſtance from A; ſo TS and RQ will repreſent the true Length of the Purloins fit for thoſe Places, RQ being the ſhorteſt, and TS the longeſt.

And as for meaſuring of them, and finding the Angles, which the Workman may think neceſſary in his Practice of Building, they are performed in all Reſpects, as has been before deſcribed in the precedent Schemes; I therefore thought it needleſs to repeat them again, but choſe rather to leave the Operations to the Reader's own Application, and ſo conclude.

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*FINIS.*

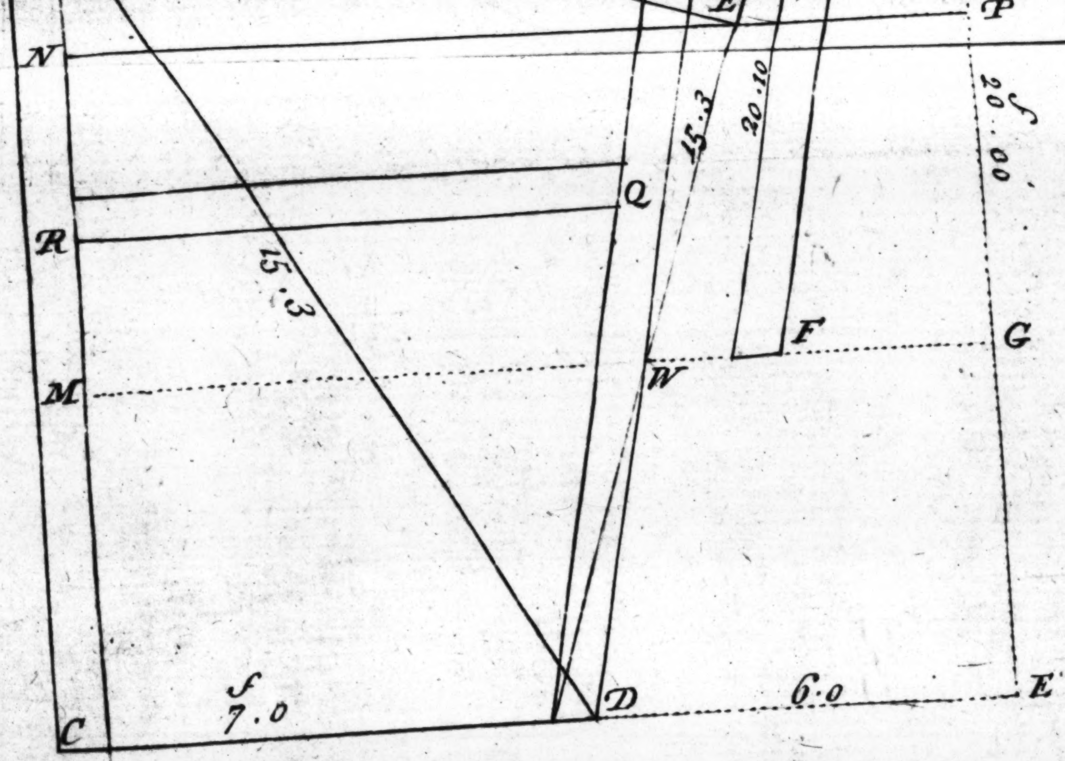
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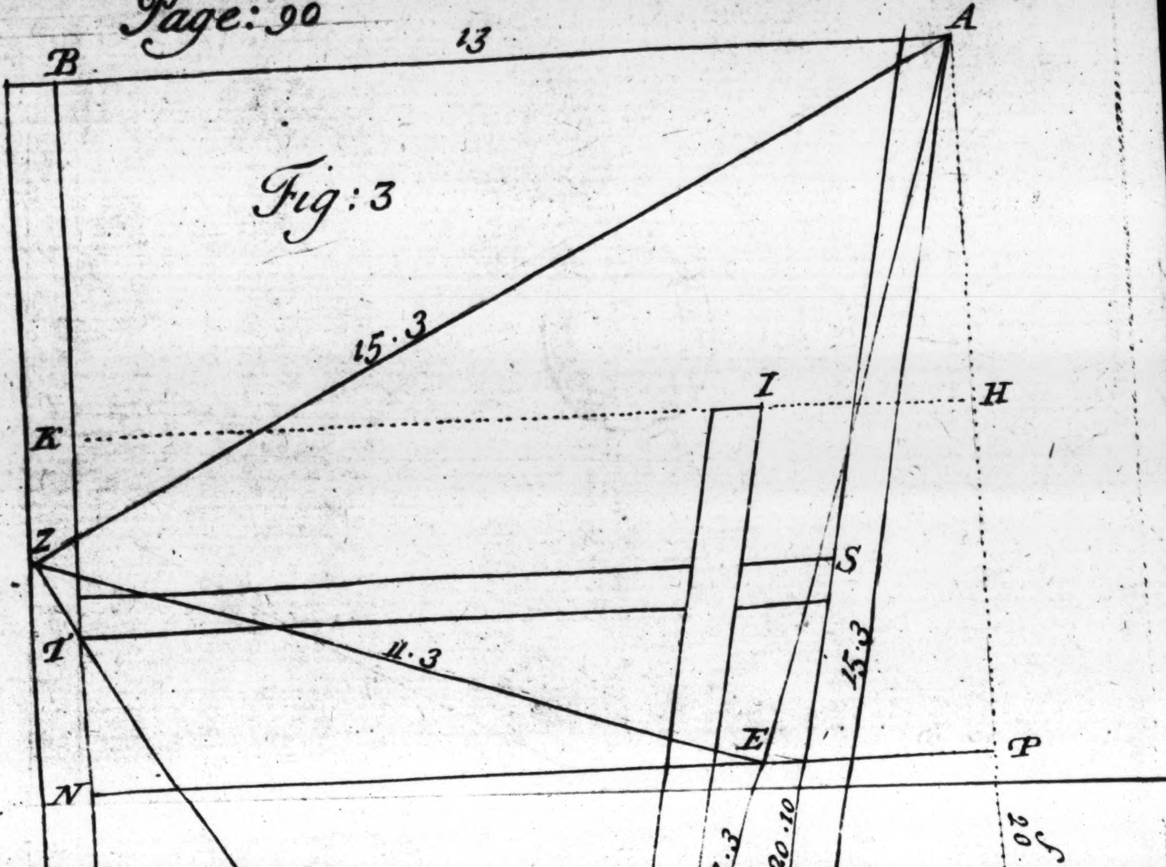
Fig: 3



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